Case No. 2007-00134

PROJECT MANUAL

RECEIVED
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PUBLIC SERVICE COMMISSION

FOR

KENTUCKY RIVER POOL 3 WATER TREATMENT PLANT

FOR

KENTUCKY - AMERICAN WATER COMPANY LEXINGTON SERVICE AREA

IP 1202-0607

MARCH 2007

ENGINEER'S PROJECT NO. 47225

Exhibit A – Specifications
Volume I

Gannett Fleming, Inc.
207 Senate Avenue
Camp Hill, PA 17011

Kentucky – American Water Company
2300 Richmond Road
Lexington, KY 40502

PROJECT MANUAL

FOR

KENTUCKY RIVER POOL 3
WATER TREATMENT PLANT

FOR

KENTUCKY-AMERICAN WATER COMPANY
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3/5/07

GANNETT FLEMING, INC.

ENVIRONMENTAL RESOURCES DIVISION

HARRISBURG, PENNSYLVANIA

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KENTUCKY-AMERICAN WATER COMPANY

KENTUCKY RIVER POOL 3
WATER TREATMENT PLANT

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INVITATION TO BID
FOR

KENTUCKY RIVER POOL 3
WATER TREATMENT PLANT

KENTUCKY-AMERICAN WATER COMPANY

Sealed Bids for furnishing all plant, labor, equipment, materials and performing all Work to construct the **Kentucky River Pool 3 Water Treatment Plant**, will be received and opened at the office of the **Kentucky-American Water Company, 2300 Richmond Road, Lexington, KY 40502, Attn: Michael Galavotti,** at **2:00 p.m.**, local time, _____, 200_. **Project includes construction of pumping and treatment facilities designed with a Phase 1 treatment capacity of 20 mgd and a hydraulic capacity of 30 mgd, with a Phase 2 - 5 mgd add-on module.**

Two (2) sets of Bidding Documents, including the Instructions to Bidders, Bid Form, Bid Bond Forms and Contract Documents, will be provided at no charge to the CONTRACTORS who are invited to bid the project. Additional copies can be obtained from **Gannett Fleming, Inc.**, at the following address: **207 Senate Avenue, Camp Hill, PA 17011 (P.O. Box 67100, Harrisburg, PA 17106-7100) Attn: Ms. Jean Herlihy**, for a fixed charge of (**$**_____) per set.

Requests for complete sets shall be forwarded to the above address and shall be accompanied by a check in the proper amount. Checks shall be made payable to **Gannett Fleming, Inc.** Checks shall be non-refundable and no refunds will be made for return of complete or partial Contract Documents.

Subcontractors, manufacturers and material suppliers should obtain information and review the Bidding Documents by contacting potential Bidders. Documents will also be available for review at the **Kentucky-American Water Company** office or the office of **Gannett Fleming, Inc**.

Each ***bid*** shall be accompanied by a Bid Bond in an amount not less than ten (10%) percent of the bid total, payable to the OWNER, all in accordance with the provisions contained in the Bidding Documents.

Each bid shall also be accompanied by either a certificate of insurance or a letter from contractor's insurance broker or company representing the availability of insurance that meets the requirements contained in the Bidding Documents.

OWNER reserves its rights to waive any informality or deficiency in any Bid, to accept any Bid, to negotiate modifications of any Bid with any Bidder and accept any modified Bid, to reject any Bid, to reject all Bids, and to rebid the Project, all at the OWNER's sole discretion.

INSTRUCTIONS TO BIDDERS

1. Defined Terms

Terms used in these Instructions to Bidders which are defined in the General Conditions of the Contract Documents have the meanings assigned to them in the General Conditions. The term "Bidder" means one who submits a Bid directly to OWNER, as distinct from a subbidder, who submits a Bid to a Bidder. The term "Successful Bidder" means the lowest, qualified, responsible and responsive Bidder to whom OWNER (on the basis of OWNER's evaluation as hereinafter provided) makes an award. The term "Bidding Documents" includes the Invitation to Bid, Instructions to Bidders, the Bid Form, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

2. Copies of Bidding Documents

2.1 Complete sets of the Bidding Documents in the number and for the amount, if any, stated in the Invitation to Bid may be obtained from the party listed on the Invitation to Bid. No refunds will be made for the return of complete or partial copies of the Bidding Documents.

2.2 Complete sets of Bidding Documents must be used in preparing Bids; neither OWNER nor ENGINEER assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.3 OWNER and ENGINEER in making copies of Bidding Documents available on the above terms do so only for the purpose of obtaining Bids on the Work and do not confer a license or grant for any other use.

3. Qualifications of Bidders

Bids are to be submitted by invitation only. Bidders must be prequalified. Each Bid must contain evidence of Bidder's qualification to do business in the state where the project is located or covenant to obtain such qualification prior to award of the contract.

4. Examination of Contract Documents and Site

4.1 It is the responsibility of each Bidder before submitting a Bid, to (a) examine the Contract Documents thoroughly, (b) visit the site to become familiar with local conditions that may affect cost, progress, performance or furnishing of the Work, (c) consider Laws and Regulations that may affect cost, progress, performance or furnishing of the Work, (d) study and carefully correlate Bidder's observations with the Contract Documents, and (e) notify ENGINEER of all conflicts, errors or discrepancies in the Contract Documents.

4.2 Reference is made to the Supplementary Conditions for identification of:

4.2.1 those reports of explorations and tests of subsurface conditions at the site which have been utilized by ENGINEER in preparation of the Contract Documents. Bidder may rely upon the accuracy of the technical data contained in such reports but not upon non-technical data, interpretations or opinions contained therein or for the completeness thereof for the purposes of bidding or construction.

4.2.2 those drawings of physical conditions in or relating to existing surface and subsurface conditions (except Underground Facilities) which are at or contiguous to the site which have been utilized by ENGINEER in preparation of the Contract Documents. Bidder may rely upon the accuracy of the technical data contained in such drawings but not upon non-technical data, interpretations or opinions contained therein or for the completeness thereof for the purpose of bidding or construction.

Copies of such reports and drawings will be made available by OWNER to any Bidder on request. Those reports and drawings are not part of the Contract Documents.

4.3 Information and data reflected in the Contract Documents with respect to Underground Facilities at or contiguous to the site is based upon information and data furnished to OWNER and ENGINEER by owners of such Underground Facilities or others, and OWNER does not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary Conditions.

4.4 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders on subsurface conditions, Underground Facilities and other physical conditions, and possible changes in the Contract Documents due to differing conditions appear in Paragraphs 4.2 and 4.3 of the General Conditions.

4.5 Before submitting a Bid, each Bidder will, at Bidder's own expense, make or obtain any additional examinations, investigations, explorations, tests and studies and obtain any additional information and data which pertain to the physical conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work and which Bidder deems necessary to determine its Bid for performing and furnishing the Work in accordance with the time, price and other terms and conditions of the Contract Documents.

4.6 On request in advance and after submittal of Bidder's evidence of insurance coverage meeting ***the requirements*** designated in the ***General and*** Supplementary Conditions, OWNER will provide each Bidder access to the site to conduct such explorations and tests as each Bidder deems necessary for submission of a Bid. Bidder shall fill all holes, clean up and restore the site to its former condition upon completion of such explorations.

4.7 The lands upon which the Work is to be performed, rights-of-way and easements for access thereto and other lands designated for use by CONTRACTOR in performing the Work are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities or storage of materials and equipment are to be provided by CONTRACTOR.

Easements for permanent structures or permanent changes in existing structures are to be obtained and paid for by OWNER unless otherwise provided in the Contract Documents.

4.8 The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this Article 4, that without exception the Bid is premised upon performing and furnishing the Work required by the Contract Documents and such means, methods, techniques, sequences or procedures of construction as may be indicated in or required by the Contract Documents, and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

5. Interpretations and Addenda

5.1 All questions about the meaning or intent of the Contract Documents are to be directed to ENGINEER. Interpretations or clarifications considered necessary by ENGINEER in response to such questions will be issued by Addenda mailed or delivered to all parties recorded by ENGINEER as having received the Bidding Documents. Questions received less than ten days prior to the date for opening of Bids may not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

5.2 Addenda may also be issued to modify the Bidding Documents as deemed advisable by OWNER or ENGINEER.

6. Bid Security

6.1 Each Bid must be accompanied by Bid security made payable to OWNER in an amount of ten percent of the Bidder's maximum Bid price and in the form of a Bid Bond (on form attached), issued by a surety meeting the requirements of Paragraph 5.1 of the General Conditions.

6.2 The Bid security of the Successful Bidder will be retained until such Bidder has executed the Agreement and furnished the required contract security, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Agreement and furnish the required contract security within fifteen days after the Notice of Award, OWNER may annul the Notice of Award and the Bid security of that Bidder will be forfeited. The Bid security of other Bidders whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the expiration of the period that bids are subject to acceptance, whereupon Bid security furnished by such Bidders will be returned. Bid security with Bids which are not competitive will be returned within Fourteen days after the Bid opening.

7. Contract Times

The times for Substantial Completion and final completion are to be set forth by Bidder in the Bid and will be included in the Agreement. The times will be taken into consideration by OWNER during the evaluation of Bids, and it will be necessary for the Successful Bidder to satisfy OWNER of Bidder's ability to achieve Substantial Completion and final completion within the times designated

in the Bid. Substantial Completion is **desired** on or before _____ __, **200_**, and Final Completion is desired on or before _____ __, **200_.**

8. Liquidated Damages

Provisions for liquidated damages, if any, are set forth in the Agreement.

9. Substitute and "Or-Equal" Items

Substitute or "Or-Equal" items are subject to the requirements of Paragraph 6.7 of the General Conditions ***and as modified by the Supplementary Conditions***.

All Bids shall be based upon the specified products. However, Bidders are encouraged to quote on alternative products by listing them in the tabulation of "Alternative Equipment and/or Materials" of the Bid Form as required by Section 1100 of the General Requirements. No later substitutes will be considered by the OWNER.

The specified products have been used in preparing the Drawings and Specifications and thus establish minimum qualities which alternatives must meet to be considered acceptable. The burden of proof of equality rests with the Bidder and adequate supporting information must be provided. The OWNER reserves the right to accept or reject proposed alternatives.

The Bid sum for each proposed alternative shall include all money required to incorporate the alternative into the project. Later requests for additional monies for alternatives will not be considered.

10. Subcontractors, Suppliers and Others

10.1 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers and other persons and organizations (including those who are to furnish the principal items of material and equipment) to be submitted to OWNER in advance of the specified date prior to the Effective Date of the Agreement, the apparent Successful Bidder, and any other Bidder so requested, shall within seven days after the Bid opening submit to OWNER a list of all such Subcontractors, Suppliers and other persons and organizations proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent organization information if requested by OWNER. If OWNER or ENGINEER after due investigation has reasonable objection to any proposed Subcontractor, Supplier, other person or organization, OWNER or ENGINEER may before the Notice of Award is given request the apparent Successful Bidder to submit an acceptable substitute without an increase in Bid price.

If apparent Successful Bidder declines to make any such substitution, OWNER may award the contract to the next lowest Bidder that proposes to use acceptable Subcontractors, Suppliers and other persons and organizations. The declining to make requested substitutions will not constitute grounds for sacrificing the Bid security of any Bidder. Any Subcontractor, Supplier, other person or organization listed and to whom OWNER or ENGINEER does not make written objection prior to

the giving of the Notice of Award will be deemed acceptable to OWNER and ENGINEER subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.8.2 of the General Conditions.

10.2 No CONTRACTOR shall be required to employ any Subcontractor, Supplier, other person or organization against whom CONTRACTOR has reasonable objection.

11. Bid Form

11.1 The Bid Form is included with the Bidding Documents; additional copies may be obtained from the party issuing the documents as listed on the Invitation to Bid.

11.2 All blanks on the Bid Form must be completed in ***blue*** ink or by typewriter. ***The bid must not contain any altered or changed (i.e., "whited-out") amounts.***

11.3 Bids by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation must be shown below the signature.

11.4 Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the signature.

11.5 ***Bids must be hand signed in blue ink by an authorized representative of the Bidder.***

11.6 All names must be typed or printed below the signatures.

11.7 The Bid shall contain an acknowledgement of receipt of all Addenda (the numbers of which must be filled in on the Bid Form ***in blue ink or by typewriter and initialed by the authorized representative of the Bidder.***)

11.8 The address and telephone number for communications regarding the Bid must be shown.

11.9 The Bid Form contains lump sum prices for two bids:

Base Bid, Phase 1, 20 mgd Plant, and;
Supplemental Bid, Phase 2, 5 mgd add-on Module.
Prices will be submitted for both bids or the entire bid will be rejected.

12. Submission of Bids

Bids shall be submitted at the time and place indicated in the Invitation to Bid and shall be enclosed in an opaque sealed envelope, marked with the Project title, ***date and time of bid opening,*** and name and address of the Bidder and accompanied by the Bid security and other required documents. If the

Bid is sent through the mail or other delivery system the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face of it. ***The bids must also conform to the following requirements:***

1. ***Only one bid per envelope will be accepted.***
2. ***No bids will be accepted after the bid opening due date and time.***
3. ***No faxed bids will be accepted.***
4. ***Non-compliance with any item within this bidding document will result in the rejection of the bid.***

13. Modification and Withdrawal of Bids

Bids may be modified or withdrawn by an appropriate document duly executed (in the manner that a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids.

14. Opening of Bids

The opening of Bids will be **private**.

15. Bids to Remain Subject to Acceptance

All Bids will remain subject to acceptance for **ninety (90) days** after the day of the Bid opening, but OWNER may, in its sole discretion, release any Bid and return the Bid security prior to the acceptance period.

16. Award of Contract

16.1 OWNER reserves the right to reject any and all Bids, to waive any and all informalities and to negotiate contract terms with the Successful Bidder, and the right to disregard all nonconforming, nonresponsive, unbalanced or conditional Bids. Also, OWNER reserves the right to reject the Bid of any Bidder if OWNER believes that it would not be in the best interest of the Project to make an award to that Bidder, whether because the Bid is not responsive or the Bidder is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by OWNER. Discrepancies in the multiplication of units of Work and Unit Prices will be resolved in favor of the Unit Prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

16.2 In evaluating Bids, OWNER will consider the qualifications of the Bidders, whether or not the Bids comply with the prescribed requirements, and such alternates, Unit Prices and other data, as may be requested in the Bid Form or prior to the Notice of Award.

16.3 OWNER may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided in the

Supplementary Conditions. OWNER also may consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

16.4 OWNER may conduct such investigations as OWNER deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of Bidders, proposed Subcontractors, Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to OWNER's satisfaction within the prescribed time.

16.5 If the contract is to be awarded, it will be awarded to the lowest Bidder whose evaluation by OWNER indicates to OWNER that the award will be in the best interests of the Project.

16.6 If the contract is to be awarded, OWNER will give the Successful Bidder a Notice of Award within the period of time that bids are subject to acceptance.

17. Contract Security ***and Insurance***

Article 5 of the General Conditions and the Supplementary Conditions set forth OWNER's requirements as to performance, payment or other Bonds ***and Insurance***. When the Successful Bidder delivers the executed Agreement to OWNER, it must be accompanied by the required Bonds ***and certificate of insurance***.

18. Signing of Agreement

When OWNER gives a Notice of Award to the Successful Bidder, it will be accompanied by the required number of unsigned counterparts of the Agreement with all other written Contract Documents attached. Within fifteen days thereafter CONTRACTOR shall sign and deliver the required number of counterparts of the Agreement and attached documents to OWNER with the required Bonds. Within ten days thereafter OWNER shall deliver one fully signed counterpart to CONTRACTOR.

19. Prebid Conference

A prebid conference will be held at **__:__ a.m./p.m.** on the **___ day** of **_____, 200_ at the Owners office at 2300 Richmond Road, Lexington, KY 40502.** Representatives of OWNER and ENGINEER will be present to discuss the Project. Bidders are **strongly encouraged** to attend and participate in the conference. ENGINEER will transmit to all prospective Bidders of record such Addenda as ENGINEER considers necessary in response to questions arising at the conference.

20. Sales and Use Taxes

As stated in the General Conditions, sales, consumer, use and similar taxes, which are legally enacted when Bids are received, shall be included in the Bid Price.

21. Retainage

Provisions concerning retainage are set forth in the Agreement.

22. Employee Background Check

Provisions concerning background checks on employees of CONTRACTOR are set forth in the Agreement.

23. Phase 1 and Phase 2 Contract Documents

The Contract Documents, Project Manual and Contract Drawings, define Base (Phase 1) and Supplemental (Phase 2) projects. The Phase 1 project is the core of the construction involving a 20 mgd intake, raw water pump station, raw water pipeline, water treatment plant, process wastewater facilities and a residuals dewatering building. The Phase 2 facilities are more fully described in the Summary of Work - Section 01000 but generally include additions to the intake; new raw water pump; new flocculator/clarifier; two new filters with one equipped for operation; clearwell expansion; new high service pump; second sludge thickener and wastewater pumps; and a third dewatering belt filter press.

In large part, the Contract Documents define the Phase 1 work. Where structures are being added, as part of Phase 2, additional drawings labeled "Phase 2" above the title block are being added to the end of each major item of work (process, electrical, etc.) set, to define the Phase 2 work. Where equipment is being installed inside of Phase 1 facilities, to define new Phase 2 work, Phase 1 drawings are presented in screened backgrounds with the Phase 2 equipment in bold linework and callouts. Phase 2 equipment or material specifications of equivalence to the Phase 1 specifications will be embedded in the Phase 1 specification section, and clearly identified as a Phase 2 item. If there is new product or materials provided in Phase 2, requiring a new specification section, that will be identified as Phase 2 and follows at the end of the Phase 1 technical specifications.

BID FORM

Date: _____ Time: _____

Signature: _____
Senior Management

Witness: _____

For Water Company Use Only

BID

PROJECT IDENTIFICATION: **KENTUCKY RIVER POOL 3**
WATER TREATMENT PLANT

THIS BID IS SUBMITTED TO: **Nick Rowe, President**
KENTUCKY-AMERICAN WATER COMPANY
2300 Richmond Road
Lexington, KY 40502-1308

---

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with OWNER in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Times indicated in this Bid and in accordance with the other terms and conditions of the Contract Documents.

2. Bidder accepts all of the terms and conditions of the Invitation to Bid and Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance as stated in paragraph 15 of the Instructions To Bidders. Bidder will sign and submit the Agreement with the Bonds and other documents required by the Bidding Requirements within fifteen days after the date of OWNER's Notice of Award.

3. In submitting this Bid, Bidder represents, as more fully set forth in the Agreement:

(a) Bidder has examined copies of all the Bidding Documents and of the following Addenda (receipt of all which is hereby acknowledged ***by completing and initialing hereunder***):

Date	Number
_____	_____
_____	_____
_____	_____

(b) Bidder has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

(c) Bidder has studied carefully all reports and drawings of subsurface conditions and drawings of physical conditions which are identified in the Supplementary Conditions as provided in Paragraph 4.2 of the General Conditions, and accepts the determination set forth in Paragraph GC-4.2.2 of the General Conditions, as may be amended by the Supplemental Conditions, of the extent the technical data contained in such reports and drawings upon which Bidder is entitled to rely.

(d) Bidder has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests and studies (in addition to or to supplement those referred to in (c) above) which pertain to the subsurface or physical conditions at the site or otherwise which may affect the cost, progress, performance or furnishing of the Work as Bidder considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of Paragraph 4.2 of the General Conditions; and no additional examinations, investigations, explorations, tests, reports or similar information or data are or will be required by Bidder for such purposes.

(e) Bidder has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities. No additional examinations, investigations, explorations, tests, reports or similar information or data in respect of said Underground Facilities are or will be required by Bidder in order to perform and furnish the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of Paragraph 4.3 of the General Conditions.

(f) Bidder has correlated the results of all such observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents.

(g) Bidder has given ENGINEER written notice of all conflicts, errors or discrepancies that it has discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to Bidder.

(h) This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; Bidder has not solicited or induced any person, firm or corporation to refrain from bidding;

and Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over OWNER.

4. Bidder will complete the Work for the price(s) shown.

Where materials are furnished by the OWNER, the prices provided herein are for installation only. Otherwise the prices include furnishing and installation of materials.

BASE BID (20 MGD PLANT) (PHASE 1) - LUMP SUM CONTRACT PRICE

_____ ($_____).
(PRICE WRITTEN IN WORDS)

SUPPLEMENTAL BID (5 MGD MODULE ADDITION) (PHASE 2) - LUMP SUM CONTRACT PRICE

_____ ($_____).
(PRICE WRITTEN IN WORDS)

The Owner is bidding a water treatment facility designed at 20 million gallons per day (mgd), expandable in 5 mgd module increments to 30 mgd. The first 5 mgd module has been designed and included with these documents and is designated, Phase 2 construction.

The Bidder must bid both, the initial Phase 1, 20 mgd plant construction and the add-on Phase 2, 5 mgd module. Failure to submit a price for both phases will be cause for rejection of the bids.

The initial award of the project will be based on the Phase 1-20 mgd plant and may include the Phase 2 - Supplemental Bid. The supplemental Bid award may be withheld until as late as February 15, 2008. The Supplemental Phase 2 Prices must be held without escalation through the February 15, 2008 date.

The award of project, if made to the lowest responsible/responsive bidder, is at the sole discretion of the Owner and may not be based solely on the lowest responsible prices submitted for the Base Bid or a combination of the Base and Supplemental Bids.

5. Bidder will provide alternative equipment and/or materials (if any) as listed below in lieu of the specified equipment and/or materials in accordance with the General Requirements in Specification Section 1100 - ALTERNATIVES.

OWNER may select items of any manufacturer or supplier listed in the following tabulation. Bidder will furnish and install such items selected for a Contract Price equal to the lump sum Contract Price, adjusted by the amount of deduction for the substituted item(s).

In the following tabulation, the name of the manufacturer or supplier entered on line (a) is the name of the manufacturer or supplier named in the Specifications for that item and the cost for providing that specified item is included in the lump sum Contract Price. If the name of the manufacturer or supplier is not shown on line (a), it is understood that the lump sum Contract Price includes the cost for providing the item furnished by the manufacturer or supplier first named in that portion of the Specification pertaining to the equipment and/or materials being substituted.

Names of alternative manufacturers and suppliers are shown on lines (b) and (c) with the respective prices to be deducted from the lump sum Contract Price should the OWNER elect to accept the alternative item.

ALTERNATIVE EQUIPMENT AND/OR MATERIALS

Spec. Section	Item and Manufacturer of Supplier	Deduct from Base Bid
_____	(a) _____	
	(b) _____	_____
	(c) _____	_____
_____	(a) _____	
	(b) _____	_____
	(c) _____	_____
_____	(a) _____	
	(b) _____	_____
	(c) _____	_____

6. Bidder agrees that the Work will be substantially complete within ___ calendar days after the date when the Contract Times commences to run as provided in Paragraph 2.3 of the General Conditions, and completed and ready for final payment within ___ calendar days after the date when the Contract Times commences to run.

Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work on time.

7. The following documents are attached to and made a condition of this Bid:

(a) Required Bid Security in the form of Bid Bond.

(b) Evidence of Bidder's qualification to do business in the State where the project is located.

(c) Bidder's contractor's license number if required to work in the State where the project is to be constructed.

(d) Information describing the proposed alternative equipment and/or materials.

(e) Evidence of availability of insurance that meets the requirements contained in the Bidding Documents.

8. The terms used in this Bid which are defined in the General Conditions of the Contract Documents have the meanings assigned to them in the General Conditions.

SUBMITTED on _____, 20____.

If Bidder is:

An Individual

By_____(SEAL)

(Individual's Name)

doing business as _____

Business address: _____

Phone No.: _____

A Partnership

By _____ (SEAL)

(Firm Name)

_____

(general partner)

Business address: _____

Phone No.: _____

A Corporation

By_____

(Corporation name)

_____

(state of incorporation)

By_____

(name of person authorized to sign)

_____

(Title)

(Corporate Seal)

Attest_____

(Secretary)

Business address: _____

Phone No.: _____

A Joint Venture

By_____

(Name)

_____

(Address)

By_____

(Name)

_____

(Address)

(Each joint venture must sign. The manner of signing for each individual, partnership and corporation that is a party to the joint venture should be in the manner indicated above).

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we _____

_____, as Principal and _____
(BIDDER)
_____ of the City of _____,

State of _____, a corporation existing under the laws and the State of _____,

and authorized to transact business in **the State of Kentucky**, as Surety, are held and firmly

bound unto **KENTUCKY-AMERICAN WATER COMPANY, 2300 Richmond Road , Lexington, KY 40502-1308**, hereinafter called the Obligee, in the sum of

_____

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

THE CONDITION OF THIS OBLIGATION IS SUCH, that whereas the Principal has submitted the accompanying Bid dated _____, 20___, for the **Kentucky River Pool 3 Water Treatment Plant**.

NOW, THEREFORE, the condition of this Bond shall be such that if the Principal, upon due acceptance of said Bid and award of a Contract to him by the Obligee, bonds with good and sufficient surety as may be required by the Contract Documents, and furnishes the Obligee proper evidence of effectiveness of insurance coverage, respectively, within the time, in the forms and in the amounts, as appropriate, required by the Contract Documents, and enters into a Contract with the Obligee in accordance with the Contract Documents, then this Bond shall be void; otherwise, the Bond shall be and shall remain in full force and effect.

The Principal and the Surety hereby stipulate and agree that if the Principal fails to perform all conditions of this Bond, they will pay the sum of the Bond to the Obligee as fixed, liquidated damages.

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 time within which the Obligee may accept such Bid; and said Surety does hereby waive notice of any such extension. It is the intention of the parties to be legally bound by this instrument.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals this _____ day of _____, 20___, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned and representative, pursuant to authority of its governing.

ATTEST:

DATE _____, 20___

WITNESS:

_____
Name of Bidder, Corporation
Firm or Individual

_____

By _____

_____
(Title)

_____

_____
Business Address of Bidder

ATTEST:

_____
Secretary

_____

_____
Surety

_____
Attorney-In-Fact

NOTE: This agreement must be properly executed and must accompany the Bid Bond as proposal security.

AGREEMENT OF SURETY

KNOW ALL MEN BY THESE PRESENTS, that we _____

_____, as Surety, a corporation existing under the laws of the State of _____, and authorized to transact business in the State of **Kentucky**; hereby agree to execute, within the time limit specified in the Contract, the Bonds, in the forms and in the amounts required for the faithful performance and proper fulfillment of the Contract for **Kentucky River Pool 3 Water Treatment Plant**, on behalf of

_____, hereinafter called the
(Bidder)

Bidder, provided that the Notice of Award be delivered to the Bidder within the time period that Bids are subject to acceptance or within any extended period for which the Bidder agrees not to withdraw his bid; and the Surety further agrees that should the Surety, after notification of such award, omit or refuse to execute the required bonds, then the Surety shall pay to the **KENTUCKY-AMERICAN WATER COMPANY** the amount of the Bid Bond.

_____ _____

Date Corporate Surety

_____ (AFFIX CORPORATE SEAL)

_____

Title

_____

_____

Business Address

AGREEMENT

THIS AGREEMENT is dated as of the _____ day of _____ in the year 20___ by and between **Kentucky-American Water Company** (hereinafter called OWNER) and _____ (hereinafter called CONTRACTOR). OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

Article 1. WORK

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

Kentucky River Pool 3 Water Treatment Plant

Article 2. ENGINEER

The ENGINEER for the Project is **Gannett Fleming, Inc.** and who is to act as OWNER's representative, assume all duties and responsibilities and have the rights and authority assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

Article 3. CONTRACT TIMES

3.1 The Work, **Phases 1 and 2**, will be substantially completed within ___ **days** from the date when the Contract Times commences to run as provided in Paragraph 2.3 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.13 of the General Conditions within ___ **days** from the date when the Contract Times commences to run.

3.2 Liquidated Damages. OWNER and CONTRACTOR recognize that time is of the essence of this Agreement and that OWNER will suffer financial loss if the Work is not completed within the times specified in Paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense and difficulties involved in providing in a legal or arbitration proceeding the actual loss suffered by OWNER if the Work is not completed on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty) CONTRACTOR shall pay OWNER _____ ($_____) for each day that expires after the times specified in Paragraph 3.1 for Substantial Completion until the Work is substantially complete. After Substantial Completion if CONTRACTOR shall neglect, refuse or fail to complete the remaining Work within the Contract Times or any

proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER _____ ($_____) for each day that expires after the times specified in Paragraph 3.1 for completion and readiness for final payment.

Article 4. CONTRACT PRICE

4.1 **Phase 1 - 20 mgd Plant and Associated Facilities -** OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents in current funds as follows: _____ ($_____)

4.2 **Phase 2 - 5 mgd Add-On Module -** OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents in current funds as follows: _____ ($_____)

Article 5. PAYMENT PROCEDURES

CONTRACTOR shall submit Applications for Payment in accordance with Article 14 of the General Conditions. Applications for Payment will be processed by ENGINEER as provided in the General Conditions.

5.1 Progress Payment. OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's Applications for Payment as recommended by ENGINEER. At intervals of once a month, the CONTRACTOR shall submit an estimate of the value of the Work completed to the first day of such month, and the value of materials and equipment suitably stored at the work site to be incorporated into the finished project. Upon approval by the OWNER, payment will be made for the net sum of ninety (90%) percent of such value less aggregate of previous payments. The net sum will be paid to the CONTRACTOR within thirty (30) days following receipt of the approved estimate.

5.2 Final Payment. Upon final completion and acceptance of the Work in accordance with Paragraph 14.13 of the General Conditions, OWNER shall pay the remainder of the Contract Price and any retained funds, as recommended by ENGINEER as provided in said Paragraph 14.13.

Article 6. CONTRACTOR'S REPRESENTATIONS

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

6.1 CONTRACTOR has familiarized itself with the nature and extent of the Contract Documents, Contract Times, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

6.2 CONTRACTOR has studied carefully all reports of explorations and tests of subsurface conditions and drawings of physical conditions which are identified in the Supplementary Conditions as provided in Paragraph 4.2 of the General Conditions, and accepts the limitations set forth in Article 4, Section 4.2 of the General Conditions.

6.3 CONTRACTOR has obtained and carefully studied (or assumes responsibility for obtaining and carefully studying) all such examinations, investigations, explorations, tests, reports and studies (in addition to or to supplement those referred to in Paragraph 6.2 above) which pertain to the subsurface or physical conditions at or contiguous to the site or otherwise which may affect the cost, progress, performance or furnishing of the Work as CONTRACTOR considers necessary for the performance or furnishing of the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of Paragraph 4.2 of the General Conditions; and no additional examinations, investigations, explorations, tests, reports, studies or similar information or data are or will be required by CONTRACTOR for such purposes.

6.4 CONTRACTOR has reviewed and checked all information and data shown or indicated on the Contract Documents with respect to existing Underground Facilities at or contiguous to the site and assumes responsibility for the accurate location of said Underground Facilities. No additional examinations, investigations, explorations, tests, reports, studies or similar information or data in respect of said Underground Facilities are or will be required by CONTRACTOR in order to perform and furnish the Work at the Contract Price, within the Contract Times and in accordance with the other terms and conditions of the Contract Documents, including specifically the provisions of Paragraph 4.3 of the General Conditions.

6.5 CONTRACTOR has correlated the results of all such observations, examinations, investigations, explorations, tests, reports and studies with the terms and conditions of the Contract Documents.

6.6 CONTRACTOR has given ENGINEER written notice of all conflicts, errors or discrepancies that he has discovered in the Contract Documents and the written resolution thereof by ENGINEER is acceptable to CONTRACTOR.

Article 7. CONTRACT DOCUMENTS

The Contract Documents, which comprise the entire agreement between OWNER and CONTRACTOR concerning the Work consist of the following:

7.1 This Agreement (pages A-1 to A-_, inclusive).

7.2 Performance and Labor and Material Payment Bonds, identified as exhibits A and B and consisting of _ pages.

7.3 Notice of Award. (Note: This document is not attached to this Agreement.)

7.4 General Conditions (Document Identification: ***12/93 – American Water System Standard General Conditions,*** pages GC-0 to GC-29, inclusive).

7.5 Supplementary Conditions (pages SC-1 to SC-_ inclusive, ***together with appendices and exhibits thereof).***

7.6 Specifications bearing the title **Kentucky River Pool 3 Water Treatment Plant**, and consisting of _____ divisions and _____ pages, as listed in table of contents thereof.

7.7 Drawings, consisting of a cover sheet and sheets numbered ____ through ____, inclusive with each sheet bearing the following general title: **Kentucky River Pool 3 Water Treatment Plant.**

(Note: Drawings have been furnished by ENGINEER and are not attached to this Agreement.)

7.8 Addenda numbers ____ to ____, inclusive.

7.9 CONTRACTOR's Bid (pages BF-1 to BF-5, inclusive) marked Exhibit C.

7.10 Documentation submitted by CONTRACTOR prior to Notice of Award (pages ____ to ____, inclusive) ***including letters dated ____ and ____ and marked Exhibit D.***

7.11 The following which may be delivered or issued after the Effective Date of the Agreement and are not attached hereto: All Written Amendments and other documents amending, modifying, or supplementing the Contract Documents pursuant to Paragraphs 3.5 and 3.6 of the General Conditions.

7.12 The documents listed in Paragraphs 7.2 et seq. above are attached to this Agreement (except as expressly noted otherwise above).

There are no Contract Documents other than those listed above in this Article 7. The Contract Documents may only be amended, modified or supplemented as provided in Paragraphs 3.5 and 3.6 of the General Conditions.

Article 8. MISCELLANEOUS

8.1 Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meaning indicated in the General Conditions.

8.2 No assignment by a party hereto of any rights under or interests in the Contract Documents will be binding on another party hereto without the written consent of the party

sought to be bound; and specifically but without limitation moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent to an assignment no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

8.3 OWNER and CONTRACTOR each binds itself, its partners, successors, assigns and legal representatives to the other party hereto, its partners, successors, assigns and legal representatives in respect of all covenants, agreements and obligations contained in the Contract Documents.

Article 9. OTHER PROVISIONS

9.1 Government Regulations

The following clauses, where applicable, are incorporated in this Agreement by reference as is fully set out; the Equal Opportunity Clause prescribed in 41 CFR 60-1.40, the Affirmative Action Clause prescribed in 41 CFR 60-250.4, regarding veterans and veterans of the Vietnam Era, and the Affirmative Action Clause for Handicapped Workers prescribed in 41 CFR 60-741.4.

CONTRACTOR accepts this Agreement and will supply any information relating to federal or state laws, rules or regulations relating to the above.

9.2 Background Check

CONTRACTOR shall conduct a background check on each of its employees prior to the employee performing any function or activity under this Agreement involving any direct customer contact, or on-site work at any of the Company's water treatment plants. As used in the Agreement, "direct customer contact" shall include but not be limited to, any activity by the CONTRACTOR's employee at or near a customer's premises. The background check conducted by CONTRACTOR shall consist of a check of at least the following: Previous employers and dates of employment; Education; Driving record; Criminal history (state and federal); References; Credit history. Prior to commencing any work under this Agreement, CONTRACTOR shall provide proof to the OWNER that the requirements of this Paragraph have been met. CONTRACTOR shall make available to the Company, upon request, the documentation and results of the background check with respect to any employee of CONTRACTOR performing any function under this Agreement involving any direct customer contact.

IN WITNESS WHEREOF, OWNER and CONTRACTOR have signed this Agreement in quadruplicate. Two counterparts have been delivered to OWNER, and one counterpart each has been delivered to CONTRACTOR and ENGINEER. All portions of the Contract Documents have been signed or identified by OWNER and CONTRACTOR or by ENGINEER on their behalf.

This Agreement will be effective on _____, 20___.

OWNER:

KENTUCKY-AMERICAN WATER COMPANY

By _____
Nick Rowe
President

(Corporate Seal)

Attest _____

Address for giving notices

2300 Richmond Road
Lexington, KY 40502

CONTRACTOR:

_____

By _____

(Corporate Seal)

Attest_____

Address for giving notices

_____

License No. _____

(If CONTRACTOR is a corporation, attach evidence authority to sign.)

Exhibit A to Agreement

LABOR AND MATERIAL PAYMENT BOND

KNOW ALL MEN BY THESE PRESENTS: that _____, having an office at _____, as Principal, hereinafter called CONTRACTOR, and _____, having an office at _____, as Surety, hereinafter called Surety, are held and firmly bound unto **Kentucky-American Water Company**, having an office at 2300 Richmond Road, Lexington, KY 40502, as Obligee, hereinafter called OWNER, for the use and benefit of claimants as herein below defined in the amount of _____ _____ $_____), for the payment whereof CONTRACTOR and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, CONTRACTOR has by written agreement dated _____, 20__, entered into a Contract with the OWNER for the construction of the project entitled **Kentucky River Pool 3 Water Treatment Plant**, in accordance with Drawings and Specifications prepared by **Gannett Fleming, Inc.**, which Contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, THE CONDITION OF THIS OBLIGATION is such that, if CONTRACTOR shall promptly make payment of all claimants as hereinafter defined, for all labor and material used or reasonably required for use in the performance of the Contract, then this obligation shall be void; otherwise it shall remain in full force and effect, subject, however to the following conditions:

1. A claimant is defined as one having a direct contract with the CONTRACTOR or with a Subcontractor of the CONTRACTOR for labor, material, or both, used or reasonably required for use in the performance of the Contract, labor and material being construed to include that part of water, gas, power, light, heat, oil, gasoline, telephone service or rental of equipment directly applicable to the Contract.

2. The above named CONTRACTOR and Surety hereby jointly and severally agreed with the OWNER that every claimant as herein defined, who has not been paid in full before the expiration of a period of ninety (90) days after the date on which the last of such claimant's work or labor was done or performed, or materials were furnished by such claimant, may sue on this bond for the use of such claimant, prosecute the suit to final judgment for such sum or sums as may be justly due claimant, and have execution thereon. The OWNER shall not be liable for the payment of any costs or expenses of any such suit.

3. No suit or action shall be commenced hereunder by any claimant:

a) Unless claimant, other than one having a direct contract with the CONTRACTOR, shall have given written notice to any two of the following: the CONTRACTOR, the OWNER or the Surety above named, within ninety (90) days after such claimant did or performed the last of the work or labor, or furnished the last of the materials for which said claim is made, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were furnished, or for whom the work or labor was done or performed. Such notice shall be served by mailing the same by registered mail or certified mail, postage prepaid, in an envelope addressed to the CONTRACTOR, OWNER or Surety, at any place where an office is regularly maintained for the transaction of business, or served in any manner in which legal process may be served in the state in which the aforesaid project is located, save that such service need not be made by a public officer.

b) After the expiration of one (1) year following the date on which CONTRACTOR ceased Work on said Contract or after the expiration of one (1) year following the Date of Substantial Completion of the Project, whichever is later, it being understood, however, that if any limitation embodied in this bond is prohibited by any law controlling the construction hereof such limitation shall be deemed to be amended so as to be equal to the minimum period of limitation permitted by such law.

c) Other than in a state court of competent jurisdiction in and for the county or other political subdivision of the state in which the project, or any part thereof, is situated, or in the United States District Court for the district in which the project, on any part thereof, is situated, and not elsewhere.

4. The amount of this bond shall be reduced by and to the extent of any payment or payments made in good faith hereunder, inclusive of the payment by Surety of mechanics' liens which may be filed of record against such improvement, whether or not claim for the amount of such lien be presented under and against this bond.

Signed and sealed this _____ day of _____, 20___.

WITNESS:

_____
CONTRACTOR (SEAL)

By_____

_____
(Witness)

_____
(Title)

WITNESS:

_____
(Name of Surety) (SEAL)

By_____
(Attach Power of Attorney)

_____
(Witness)

_____
(Title)

Exhibit B to Agreement

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENTS: that _____, having an office at _____, as Principal, hereinafter called CONTRACTOR, and _____, having an office at _____, as Surety, hereinafter called Surety, are held and firmly bound unto the **Kentucky-American Water Company**, having an office at 2300 Richmond Road, Lexington, KY 40502, as Obligee, hereinafter called OWNER, for the use and benefit of claimants as herein below defined, in the amount of

_____

($_____), for the payment whereof CONTRACTOR and Surety bind themselves, their heirs, executors, administrations, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, CONTRACTOR has by written agreement dated _____, 20___, entered into a Contract with the OWNER for the construction of the project entitled **Kentucky River Pool 3 Water Treatment Plant**, in accordance with Drawings and Specifications prepared by **Gannett Fleming, Inc.**, which Contract is by reference made a part hereof, and is hereinafter referred to as the Contract.

NOW, THEREFORE, the condition of this obligation is such that, if CONTRACTOR shall promptly and faithfully perform said Contract, then this obligation shall be null and void; otherwise it shall remain in full force and effect.

The Surety hereby waives notice of any alteration or extension of Contract Times made by the OWNER.

Whenever CONTRACTOR shall be and declared by OWNER to be in default under the Contract, the Surety shall promptly remedy the default. If the OWNER terminates the Contract for such default, the following precautions shall govern the liability of the CONTRACTOR and the Surety hereunder.

In the event of such termination, the CONTRACTOR and the Surety shall remain fully liable to the OWNER for the CONTRACTOR'S failure to timely complete the Contract, any additional costs incurred by the OWNER in completing the Contract, and liquidated damages from the originally scheduled completion date to the date of the actual completion of the work by the OWNER.

In the event of such termination, the Surety company may elect to take over and complete performance of the Contract by giving written notice to the OWNER of such determination within seven (7) days of the OWNER'S mailing of notice of termination to the Surety and actually commencing completion with fourteen (14) days of the OWNER'S notice to the Surety. The Surety shall fully complete the work by the originally scheduled date of completion and the CONTRACTOR

and the Surety shall remain liable to the OWNER for all damages sustained by the OWNER and for liquidated damages for delay.

Any suit under this bond must be instituted before the expiration of two (2) years from the date on which final payment under the Contract falls due or before the expiration of two (2) years from the Date of Substantial Completion of the Project, whichever is later.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the OWNER named herein or the heirs, executors, administrators or successors of the OWNER.

Signed and sealed this _____ day of _____, 20___.

WITNESS:

_____
CONTRACTOR (SEAL)

By_____

_____
(Witness)

_____
(Title)

WITNESS:

_____
(Name of Surety) (SEAL)

_____ By_____
(Witness) (attach Power of Attorney)

_____
(Title)

GENERAL CONDITIONS

The General Conditions contained in this part of the Contract Documents are based on the Standard General Conditions of the Construction Contract prepared by the Engineers Joint Contract Documents Committee with modifications to be consistent with American Water System Policies. Only the General Conditions contained herein are a part of the Contract Documents for the project.

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GENERAL CONDITIONS

ARTICLE 1 - DEFINITIONS

Whenever used in these General Conditions or in the other Contract Documents the following terms have the meanings indicated which are applicable to both the singular and plural thereof:

1.1 *Addenda* -- Written or graphic instruments issued prior to the opening of Bids which clarify, correct or change the bidding requirements or the Contract Documents.

1.2 *Agreement* -- The written contract between OWNER and CONTRACTOR covering the Work to be performed; other Contract Documents are attached to the Agreement and made a part thereof as provided therein.

1.3 *Application for Payment* -- The form accepted by ENGINEER which is to be used by CONTRACTOR in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

1.4 *Asbestos* -- Any material that contains more than one percent asbestos and is friable or is releasing asbestos fibers into the air above current action levels established by the United States Occupational Safety and Health Administration.

1.5 *Bid* -- The offer or proposal of the bidder submitted on the prescribed form setting forth the prices for the Work to be performed.

1.6 *Bonds* -- Performance and Payment bonds and other instruments of security.

1.7 *Change Order* -- A document recommended by ENGINEER which is signed by CONTRACTOR and OWNER and authorizes an addition, deletion or revision in the Work, or an adjustment in the Contract Price or the Contract Times, issued on or after the Effective Date of the Agreement.

1.8 *Contract Documents* -- The Agreement, Addenda (which pertain to the Contract Documents), CONTRACTOR's Bid (including documentation accompanying the Bid and any post-Bid documentation submitted prior to the Notice of Award) when attached as an exhibit to the Agreement, the Bonds, these General Conditions, the Supplementary Conditions, the Specifications and the Drawings as the same are more specifically identified in the Agreement, together with all Written Amendments, Change Orders, Work Change Directives, Field Orders and ENGINEER's written interpretations and clarifications issued pursuant to paragraphs 3.5, 3.6.1, and 3.6.3 on or after the Effective Date of the Agreement. Shop Drawing submittals approved pursuant to paragraphs 6.26 and 6.27 and the reports and drawings referred to in paragraphs 4.2.1 and 4.2.2 are not Contract Documents.

1.9 *Contract Price* -- The moneys payable by OWNER to CONTRACTOR for completion of the Work in accordance with the Contract Documents as stated in the Agreement (subject to the provisions of paragraph 11.9.1 in the case of Unit Price Work).

1.10 *Contract Times* -- The number of days or the dates stated in the Agreement (i) to achieve Substantial Completion, and (ii) to complete the Work so that it is ready for final payment as evidenced by ENGINEER's written recommendation of final payment in accordance with paragraph 14.13.

1.11 *CONTRACTOR* -- The person, firm or corporation with whom OWNER has entered into the Agreement.

1.12 *Defective* -- An adjective which when modifying the word Work refers to Work that is unsatisfactory, faulty or deficient, in that it does not conform to the Contract Documents, or does not meet the requirements of any inspection, reference standard, test or approval referred to in the Contract Documents, or has been damaged prior to ENGINEER's recommendation of final payment (unless responsibility for the protection thereof has been assumed by OWNER at Substantial Completion in accordance with paragraph 14.8 or 14.10).

1.13 *Drawings* -- The drawings which show the scope, extent and character of the Work to be furnished and performed by the CONTRACTOR and which have been prepared or approved by ENGINEER and are referred to in the Contract Documents. Shop Drawings are not Drawings as so defined.

1.14 *Effective Date of the Agreement* -- The date indicated in the agreement on which it becomes effective, but if no such date is indicated it means the date on which the Agreement is signed and delivered by the last of the two parties to sign and deliver. However, the contractor has no rights or remedies arising from execution of the Agreement prior to the Commencement of Contract Times.

1.15 *ENGINEER* -- The person, firm or corporation named as such in the Agreement.

1.16 *ENGINEER's Consultant* -- A person, firm or corporation having a contract with OWNER to furnish professional services for the benefit of OWNER and ENGINEER with respect to the Project and who is identified as such in the Supplementary Conditions. The term ENGINEER's Consultant shall be deemed also to include a person, firm or corporation having a contract with ENGINEER's Consultant to furnish professional services as an independent professional associate or consultant to ENGINEER's Consultant with respect to the Project and who is identified as such in the Supplementary Conditions.

1.17 *Field Order* -- A written order issued by ENGINEER which orders minor changes in the Work in accordance with paragraph 9.5 but which does not involve a change in the Contract Price or the Contract Times.

1.18 *General Requirements* -- Sections of Division 1 of the Specifications.

1.19 *Hazardous Waste* -- The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 9603) as amended from time to time.

1.20 *Laws and Regulations: Laws or Regulations* -- Any and all applicable laws, rules, regulations, ordinances, codes and orders of any and all governmental bodies, agencies, authorities or courts having jurisdiction.

1.21 *Liens* -- Liens, charges, security interests or encumbrances upon real or personal property.

1.22 *Notice of Award* -- The written notice to the apparent successful bidder stating that upon compliance by the apparent successful bidder with the conditions precedent enumerated therein, within the time specified, OWNER will sign and deliver the Agreement.

1.23 *Notice to Proceed* -- A written notice to CONTRACTOR fixing the date on which the Contract Time will commence to run and on which CONTRACTOR shall start to perform CONTRACTOR's obligations under the Contract Documents.

1.24 *OWNER* -- The public body or authority, corporation, association, firm or person with whom CONTRACTOR has entered into the Agreement and for whom the Work is to be provided.

1.25 *Partial Utilization* -- Use by OWNER of a finished part of the Work for the purpose for which it is intended (or a related purpose) before reaching Substantial Completion for all the Work.

1.26 *Petroleum* -- Petroleum, including crude oil or any fraction thereof which is liquid at standard conditions of temperature and pressure (60 degrees Fahrenheit and 14.7 pounds per square inch absolute), such as oil, petroleum, fuel oil, oil sludge, oil refuse, gasoline and kerosene and oil mixed with other non-Hazardous Wastes and crude oils.

1.27 *PCBs* -- Shall mean Polychlorinated Biphenyls.

1.28 *Project* -- The total construction of which the Work to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

1.29 *Radioactive Material* -- Source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, (42 USC Section 2011 et seq.) as amended from time to time.

1.30 *Resident Project Representative* -- The authorized representative of ENGINEER who may be assigned to the site or any part thereof.

1.31 *Samples* -- Physical examples of materials, equipment or workmanship that are representative of some portion of the Work and which establish the standards by which such portion of the Work will be judged.

1.32 *Shop Drawings* -- All drawings, diagrams, illustrations, schedules and other data or information which are specifically prepared or assembled by or for CONTRACTOR and submitted by CONTRACTOR to illustrate some portion of the Work.

1.33 *Specifications* -- Those portions of the Contract Documents consisting of written technical descriptions of materials, equipment, construction systems, standards and workmanship as applied to the Work and certain administrative details applicable thereto.

1.34 *Specifications Special Conditions* -- The part of the Contract Documents if used, that amends or supplements the Specifications.

1.35 *Subcontractor* -- An individual, firm or corporation having a direct contract with CONTRACTOR or with any other Subcontractor for the performance of a part of the Work at the site.

1.36 *Substantial Completion* -- The Work (or a specified part thereof) has progressed to the point where, in the opinion of ENGINEER as evidenced by ENGINEER's definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended; or if no such certificate is issued, when the Work is complete and ready for final payment as evidence by ENGINEER's written recommendation of final payment in accordance with paragraph 14.13. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

1.37 *Supplementary Conditions* -- The part of the Contract Documents which amends or supplements these General Conditions.

1.38 *Supplier* -- A manufacturer, fabricator, supplier, distributor, materialman or vendor having a direct contract with CONTRACTOR or with any Subcontractor to furnish materials or equipment to be incorporated in the Work by CONTRACTOR or any Subcontractor.

1.39 *Underground Facilities* -- All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasements containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephones or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

1.40 *Unit Price Work* -- Work to be paid for on the basis of unit prices.

1.41 *Work* --The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work includes and is the result of performing or furnishing labor and furnishing and incorporating materials and equipment into the construction and performing or furnishing services and furnishing documents, all as required by the Contract Documents.

1.42 *Work Change Directive* -- A written directive to CONTRACTOR, issued on or after the Effective Date of the Agreement and signed by OWNER and recommended by ENGINEER, ordering an addition, deletion or revision in the Work, or responding to differing or unforeseen physical conditions under which the Work is to be performed as provided in paragraph 4.2 or 4.3 or to emergencies under paragraph 6.23. A Work Change Directive will not change the Contract Price or the Contract Times, but is evidence that the parties expect that the change directed or documented by a Work Change Directive will be incorporated in a subsequently issued Change Order following negotiations by the parties as to its effect, if any, on the Contract Price or Contract Times as provided in paragraph 10.2.

1.43 *Written Amendment* -- A written amendment of the Contract Documents, signed by OWNER and CONTRACTOR on or after the Effective Date of the Agreement and normally dealing with the nonengineering or nontechnical rather than strictly construction-related aspects of the Contract Documents.

ARTICLE 2 - PRELIMINARY MATTERS

Delivery of Bonds:

2.1 When CONTRACTOR delivers the executed Agreements to OWNER, CONTRACTOR shall also deliver to OWNER such Bonds as CONTRACTOR may be required to furnish in accordance with paragraph 5.1.

Copies of Documents:

2.2 OWNER shall furnish to CONTRACTOR up to ten copies (unless otherwise specified in the Supplementary Conditions) of the Contract Documents as are reasonably necessary for the execution of the Work. Additional copies will be furnished, upon request, at the cost of reproduction.

Commencement of Contract Times; Notice to Proceed:

2.3 The Contract Times will commence to run on the thirtieth day after the Effective Date of the Agreement, or, if a Notice to Proceed is given, on the day indicated in the Notice to Proceed. A Notice to Proceed may be given at any time within thirty days after the Effective Date of the Agreement. In no event will owner have any obligations or duties to CONTRACTOR under the Agreement until Contract Times commence to run.

Starting the Work:

2.4 CONTRACTOR shall start to perform the Work on the date when the Contract Times commence to run, but no Work shall be done at the site prior to the date on which the Contract Times commence to run.

Before Starting Construction:

2.5 Before undertaking each part of the Work, CONTRACTOR shall carefully study and compare the Contract Documents and check and verify pertinent figures shown thereon and all applicable field measurements. CONTRACTOR shall promptly report in writing to ENGINEER any conflict, error, ambiguity or discrepancy which CONTRACTOR may discover and shall obtain a written interpretation or clarification from ENGINEER before proceeding with any Work affected thereby; however, CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any conflict, error, ambiguity or discrepancy in the Contract Documents, unless CONTRACTOR knew or should have known thereof.

2.6 Within ten days after the Effective Date of the Agreement (unless otherwise specified in Division 1 -General Requirements), CONTRACTOR shall submit to ENGINEER for review:

2.6.1 a preliminary progress schedule indicating the times (number of days or dates) for starting and completing the various stages of the Work, including any principal events (milestones) specified in the Contract Documents;

2.6.2 a preliminary schedule of Shop Drawings and Sample submittals which will list each required submittal and the times for submitting, reviewing and processing such submittal;

2.6.3 a preliminary schedule of values for all of the Work which will include quantities and prices of items aggregating the Contract Price and will subdivide the Work into component parts in sufficient detail to serve as the basis for progress payments during construction.

2.7 Before any Work at the site is started, CONTRACTOR and OWNER shall each deliver to the other, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance which either of them or any additional insured may reasonably request) which CONTRACTOR and OWNER respectively are required to purchase and maintain in accordance with paragraphs 5.4, 5.6 and 5.7.

Preconstruction Conference:

2.8 Within twenty days after the Contract Times start to run, but before any Work at the site is started, a conference attended by CONTRACTOR, ENGINEER and others as appropriate will be held to establish a working understanding among the parties as to the Work and to discuss the schedules referred to in paragraph 2.6, procedures for handling Shop Drawings and other submittals, processing Applications for Payments, and maintaining required records.

Finalizing Schedules:

2.9 Unless otherwise provided in the Supplementary Conditions, at least ten days before submission of the first Application for Payment a conference attended by CONTRACTOR, ENGINEER and others as appropriate will be held to finalize the schedules submitted in accordance with paragraph 2.6. CONTRACTOR shall have an additional ten days to make corrections and adjustments and to complete and submit the finalized schedules. No progress payment shall be made to CONTRACTOR until the finalized schedules are submitted to and acceptable to the ENGINEER as provided below. The finalized progress schedule will be as indicated in the Specifications and will be acceptable to ENGINEER as providing an orderly progression of the Work to completion within any specified milestone completion Times and the Contract Times, but such acceptance will neither impose on ENGINEER responsibility for the sequencing scheduling or progress of the Work nor relieve CONTRACTOR from full responsibility therefore. CONTRACTOR's finalized schedule of Shop Drawings and Sample submissions will be acceptable to ENGINEER as providing a workable arrangement for reviewing and processing the submittals. The CONTRACTOR's finalized schedule of values will be acceptable to ENGINEER as to form and substance.

ARTICLE 3 -- CONTRACT DOCUMENTS: INTENT, AMENDING, REUSE

Intent:

3.1 The Contract Documents comprise the entire agreement between OWNER and CONTRACTOR concerning the Work. The Contract Documents are complementary; what is called for by one is as binding as if called for by all. The Contract Documents will be construed in accordance with the law of the place of the Project.

3.2 It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any Work, materials or equipment that may reasonably be inferred from the Contract Documents or from prevailing custom or trade usage as being required to produce the intended result will be furnished and performed whether or not specifically called for. When words or phrases which have a well-known technical or construction industry or trade meaning are used to describe Work, materials or equipment such words or phrases shall be interpreted in accordance with that meaning. Clarifications and interpretations of the Contract Documents shall be issued by ENGINEER as provided in paragraph 9.4.

3.3 Reference to Standards and Specifications of Technical Societies; Reporting and Resolving Discrepancies:

3.3.1 Reference to standards, specifications, manuals or codes of any technical society, organization or association, or to the Laws or Regulations of any governmental authority, whether such reference be specific or by implication, shall mean the latest standard, specification, manual, code or Laws or Regulations in effect at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids), except as may be otherwise specifically stated in the Contract Documents.

3.3.2 If, during the performance of the Work, CONTRACTOR discovers any conflict, error, ambiguity or discrepancy between the Contract Documents and any provision of any such Law or Regulation applicable to the performance of the Work or of any such standard, specification, manual or code or of any instruction of any Supplier referred to in paragraph 6.5, CONTRACTOR shall report it to ENGINEER in writing at once, and, CONTRACTOR shall not proceed with the Work affected thereby (except in an emergency as authorized by paragraph 6.23) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in paragraphs 3.5 or 3.6; provided, however, that CONTRACTOR shall not be liable to OWNER or ENGINEER for failure to report any such conflict, error, ambiguity or discrepancy unless CONTRACTOR knew or should have known thereof.

3.3.3 Except as otherwise specifically stated in the Contract Documents or as may be provided by amendment or supplement thereto issued by one of the methods indicated in paragraph 3.5 or 3.6, the provisions of the Contract Documents shall take precedence in resolving any conflict, error, ambiguity or discrepancy between the provisions of the Contract Documents and:

3.3.3.1 the provisions of any such standard, specification, manual, code or instruction (whether or not specifically incorporated by reference in the Contract Documents); or

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

No provisions of any such standard, specification, manual, code or instruction shall be effective to change the duties and responsibilities of OWNER, CONTRACTOR or ENGINEER or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents, nor shall it be effective to assign to OWNER, ENGINEER or any of ENGINEER's Consultants, agents or employees any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of paragraph 9.13 or any other provision of the Contract Documents.

3.4 Whenever in the Contract Documents the terms "as ordered", "as directed", "as required", "as allowed", "as approved", or terms of like effect or import are used, or the adjectives "reasonable", "suitable", "acceptable", "proper" or "satisfactory" or adjectives of like effect or import are used to describe a requirement, direction, review or judgement of ENGINEER as to the Work, it is intended that such requirement, direction, review or judgement will be solely to evaluate, in general, the completed Work for compliance with the information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as indicated by and reflected in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective shall not be effective to assign to ENGINEER any duty or authority to supervise or direct the furnishing or performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of paragraph 9.13 or any other provision of the Contract Documents. Where "provide" is used in the Specifications or Drawings, it shall be understood to mean, "provide complete in place", that is, furnish and install.

Amending and Supplementing Contract Documents:

3.5 The Contract Documents may be amended to provide for additions, deletions and revisions in the Work or to modify the terms and conditions thereof in one or more of the following ways:

3.5.1 a formal Written Amendment,

3.5.2 a Change Order (pursuant to paragraph 10.4), or

3.5.3 a Work Change Directive (pursuant to paragraph 10.1).

3.6 In addition, the requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, in one or more of the following ways:

3.6.1 a Field Order (pursuant to paragraph 9.5),

3.6.2 ENGINEER's approval of a Shop Drawing or sample (pursuant to paragraphs 6.26 and 6.27), or

3.6.3 ENGINEER's written interpretation or clarification (pursuant to paragraph 9.4).

3.6.4 Any variations and deviation in the Work arising from any of the methods set forth in Paragraph 3.6 will not authorize any ammendment to the Contract Price or Contract Times. The sole method to amend the Contract Price or Contract Times is pursuant to Paragraph 3.5.

Reuse of Documents:

3.7 CONTRACTOR, and any Subcontractor or Supplier or other person or organization performing or furnishing any of the Work under a direct or indirect contract with OWNER (i) shall not have or acquire any title to or ownership rights in any of the Drawings, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of ENGINEER, or ENGINEER's Consultant; and (ii) shall not reuse any of such Drawings, Specifications, other documents or copies or extensions of the Project or any other project without written consent of OWNER and ENGINEER and specific written verification or adaption by ENGINEER.

ARTICLE 4 -- AVAILABILITY OF LANDS; SUBSURFACE AND PHYSICAL CONDITIONS; REFERENCE POINTS

Availability of Lands:

4.1 OWNER shall furnish, as indicated in the Contract Documents, the lands upon which the Work is to be performed, rights-of-way and easements for access thereto, and such other lands which are designated for the use of CONTRACTOR. Upon reasonable written request, OWNER shall furnish CONTRACTOR with a correct statement of record legal title and legal description of the lands upon which the Work is to be performed and OWNER's interest therein as necessary for giving notice of or filing a mechanic's lien against such lands in accordance with applicable Laws and Regulations. OWNER shall identify any encumbrances or restrictions not of general application but specifically related to use of lands so furnished with which CONTRACTOR will have to comply in performing the Work. Easements for permanent structures or permanent changes in existing facilities will be obtained and paid for by OWNER, unless otherwise provided in the Contract Documents. If CONTRACTOR and OWNER are unable to agree on entitlement to or the amount or extent of any adjustments in the Contract Price or the Contract Times as a result of any delay in OWNER's furnishing these lands, right-of-way or easements, CONTRACTOR may make a claim therefor as provided in Articles 11 and 12. CONTRACTOR shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

4.2 Subsurface and Physical Conditions:

4.2.1 Reports and Drawings: Reference is made to the Supplementary Conditions for identification of:

4.2.1.1 Subsurface Conditions at the Site: Those reports of explorations and tests of subsurface conditions at the site that have been utilized by ENGINEER in preparation of the Contract Documents; and

4.2.1.2 Physical Conditions: Those drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the site (except Underground Facilities) that have been utilized by the ENGINEER in preparing the Contract Documents.

4.2.2 Limited Reliance by CONTRACTOR Authorized; Technical Data: CONTRACTOR may rely upon the accuracy of the technical data contained in such reports and drawings, but such reports and drawings are not Contract Documents. Except for such reliance on technical data, CONTRACTOR may not rely upon and shall make no claim against OWNER, ENGINEER or any of the

ENGINEER's Consultants with respect to:

4.2.2.1 the completeness of such reports and drawings for CONTRACTOR's purposes,

4.2.2.2 nontechnical data, interpretations, opinions and information contained in such reports or otherwise relating to subsurface conditions at the site, or

4.2.2.3 nontechnical data, interpretations, opinions and information shown or indicated in such drawings or otherwise relating to such structures.

4.2.3 Reports of Differing Subsurface or Physical Conditions: If any subsurface or latent physical condition at the site that is uncovered or revealed (i) differs materially from that shown or indicated in the Contract Documents, or (ii) is of an unusual nature, which differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents, or (iii) is of such a nature as to require a change in the Contract Documents, or (iv) is of such a nature as to establish that any technical data on which CONTRACTOR is entitled to rely as provided in paragraphs 4.2.1 and 4.2.2 is materially inaccurate, then CONTRACTOR shall, promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as permitted by paragraph 6.23), notify OWNER and ENGINEER in writing about such condition.

4.2.4 ENGINEER's Review: ENGINEER will promptly review the pertinent conditions, determine the necessity of OWNER's obtaining additional explorations or tests with respect thereto and advise OWNER in writing (with a copy to CONTRACTOR) of ENGINEER's findings and conclusions.

4.2.5 Possible Contract Documents Change: If ENGINEER concludes that a change in the Contract Documents is required as a result of a condition described in paragraph 4.2.3, a Work Change Directive or a Change Order will be issued as provided in Article 10 to reflect and document the consequences of such change.

4.2.6 Possible Price and Time Adjustments: If a condition described in paragraph 4.2.3 causes an increase or decrease in the Contract Price or Contract Times, an equitable adjustment in the Contract Price (subject to the provisions of paragraphs 9.10 and 11.9 with respect to Unit Price Work) or an equitable adjustment of the Contract Times, or any combination thereof, will be allowed, to the extent that such condition has caused an increase or decrease in CONTRACTOR's cost of, or time required for performance of the Work, whether or not the Contract Documents are changed pursuant to paragraph 4.2.5, provided that:

4.2.6.1 such subsurface or physical condition was unknown to and could not reasonably have been anticipated by CONTRACTOR, and

4.2.6.2 such subsurface or physical condition meets the criteria established in paragraph 4.2.3, and

4.2.6.3 CONTRACTOR has timely given the written notice required by paragraph 4.2.3, and

4.2.6.4 CONTRACTOR has complied with the requirements of Article 6 of the Agreement.

If OWNER and CONTRACTOR are unable to agree on entitlement to or as to the amount or length of any such equitable adjustment in the Contract Price or Contract Times, a claim may be made therefor as provided in Articles 11 and 12. However, OWNER, ENGINEER and ENGINEER's Consultants shall not be liable to CONTRACTOR for any costs, losses or damages sustained by CONTRACTOR on or in connection with any other project or anticipated project or that otherwise do not increase CONTRACTOR's cost of the Work.

4.3 Physical Conditions -- Underground Facilities:

4.3.1 Shown or Indicated: The information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to OWNER or ENGINEER by the owners of such Underground Facilities or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

4.3.1.1 OWNER and ENGINEER shall not be responsible for the accuracy or completeness of any such information or data; and

4.3.1.2 The cost of all of the following will be included in the Contract Price and CONTRACTOR shall have full responsibility for: (i) reviewing and checking all such information and data, (ii) locating all Underground Facilities shown or indicated in the Contract Documents, (iii) coordination of the Work with the owners of such Underground Facilities during construction, and (iv) the safety and protection of all such Underground Facilities as provided in paragraph 6.20 and repairing any damage thereto resulting from the Work.

4.3.2 Not Shown or Indicated: If an Underground Facility is uncovered or revealed at or contiguous to the site which was not shown or indicated in the Contract Documents, CONTRACTOR shall promptly after becoming aware thereof and before further disturbing conditions affected thereby or performing any Work in connection therewith (except in an emergency as required by paragraph 6.23), identify the owner of such Underground Facility and give

written notice thereof to that owner and to OWNER and ENGINEER. ENGINEER will promptly review the Underground Facility and determine the extent, if any, to which a change is required in the Contract Documents to reflect and document the consequence of the existence of the Underground Facility. If ENGINEER concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued as provided in Article 10 to reflect and document such consequences. During such time, CONTRACTOR shall be responsible for the safety and protection of such Underground Facility as provided in paragraph 6.20. CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Times, or both, to the extent that they are attributable to the existence of any Underground Facility that was not shown or indicated in the Contract Documents and that CONTRACTOR did not know of and could not reasonably have been expected to be aware of or to have anticipated. If OWNER and CONTRACTOR are unable to agree on entitlement to or the amount or length of any such adjustment in Contract Times or Contract Price, CONTRACTOR may make a claim therefor as provided in Articles 11 and 12.

However, OWNER, ENGINEER and ENGINEER's Consultants shall not be liable to CONTRACTOR for any costs, losses or damages sustained by CONTRACTOR on or in connection with any other project or anticipated project or that otherwise do not increase CONTRACTOR's cost of the Work.

Reference Points:

4.4 OWNER shall provide engineering surveys to establish reference points for construction which in ENGINEER's judgement are necessary to enable CONTRACTOR to proceed with the Work. CONTRACTOR shall be responsible for laying out the Work, shall protect and preserve the established reference points and shall make no changes or relocations without the prior written approval of OWNER. CONTRACTOR shall report to ENGINEER whenever any reference point is lost or destroyed or requires relocation because of necessary changes in grades or locations, and shall be responsible for the accurate replacement or relocation of such reference points by professionally qualified personnel.

4.5 Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material:

4.5.1 OWNER shall be responsible for any Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material uncovered or revealed at the site which was not shown or indicated in Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work and which may present a substantial danger to persons or property exposed thereto in connection with the Work at the site. OWNER shall not be responsible for any such materials brought onto the job site by CONTRACTOR, Subcontractors, Suppliers or anyone else for whom CONTRACTOR is responsible.

4.5.2 CONTRACTOR shall immediately (i) stop all Work in connection with such hazardous condition and in any area affected thereby (except in an emergency as required by paragraph 6.23) and (ii) notify OWNER and ENGINEER (and thereafter confirm such notice in writing). OWNER shall promptly consult with ENGINEER concerning the necessity for OWNER to retain a qualified expert to evaluate such hazardous condition or take corrective action, if any. CONTRACTOR shall not be required to resume Work in connection with such hazardous condition or in any such affected area until after OWNER has obtained any required permits related thereto and delivered to CONTRACTOR special written notice (i) specifying that such condition and any affected area is or has been rendered safe for the resumption of Work, or (ii) specifying any special conditions under which such Work may be resumed safely. If OWNER and CONTRACTOR cannot agree as to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of such Work stoppage or such special conditions under which Work is agreed by CONTRACTOR to be resumed, either party may make a claim therefor as provided in Articles 11 and 12.

4.5.3 If after receipt of such special written notice CONTRACTOR does not agree to resume such Work based on a reasonable belief it is unsafe, or does not agree to resume such Work under such special conditions, then OWNER may order such portion of the Work that is in connection with such hazardous condition or in such affected area to be deleted from the Work. If OWNER and CONTRACTOR cannot agree to entitlement to or the amount or extent of an adjustment, if any, in Contract Price or Contract Times as a result of deleting such portion of the Work, then either party may make a claim therefor as provided in Articles 11 and 12. OWNER may have such deleted portion of the Work performed by OWNER's own forces or others in accordance with Article 7.

4.5.4 To the fullest extent permitted by Laws and Regulations OWNER shall indemnify and hold harmless CONTRACTOR and ENGINEER and their respective officers, directors, consultants, Subcontractors, agents and employees from and against all claims, damages, losses and expenses, direct, indirect or consequential (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs) arising out of or resulting from such hazardous condition, provided that (a) any such claim, damage, loss or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom, and (b) nothing in this subparagraph 4.5.4 shall obligate OWNER to indemnify any person or entity from and against the consequences of that person's or entity's own negligence.

4.5.5 The provisions of paragraphs 4.2 and 4.3 are not intended to apply to Asbestos, PCB's, Petroleum, Hazardous

Waste or Radioactive Material uncovered or revealed at the site.

4.5.6 In accordance with the intent of the Federal Occupational Safety and Health Administration (OSHA) Standard Section 29CFR-1910.12, Hazard Communication with effective date of May 25, 1986, as it may be amended from time to time, the OWNER hereby notifies the CONTRACTOR Work is to be performed on company property where the CONTRACTOR's employees may be exposed to hazardous materials existing on the premises.

Chemicals known to be used or stored by the OWNER and required to be disclosed by said OSHA Standard Section 29CFR-1910.12 are listed in the Supplementary Conditions.

OWNER, CONTRACTOR and any Subcontractors will each provide or make available to the others: (a) any written hazard communication program required to be maintained with respect to the site and any material safety data sheet and other hazard communication information required to be provided in accordance with applicable Laws and applicable Regulations, or (b) in the event that applicable Laws and Regulations do not require the provision or exchange of such hazard communications, CONTRACTOR and any Subcontractors shall, nevertheless, provide or make available to OWNER and any other employers at the site a written hazard communication program, material safety data sheets and other hazard communication information of the type and consistent with the intent of said OSHA Standard Section 29CFR-1910.12 and acceptable to OWNER and ENGINEER. CONTRACTOR shall be responsible for coordinating any such required exchange of documents or information between or among OWNER, and any other employers at the site, or any of them. CONTRACTOR shall include the provisions of this paragraph 4.5.6 in any subcontract for any part of the Work at the site.

ARTICLE 5 -- BONDS AND INSURANCE

Performance and Other Bonds:

5.1 CONTRACTOR shall furnish a Performance Bond, and a Labor and Material Payment Bond, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all CONTRACTOR's obligations under the Contract Documents. These Bonds shall remain in effect at least until one year after the date when final payment becomes due, except as otherwise provided by Laws or Regulations or by the Contract Documents. CONTRACTOR shall also furnish such other Bonds as are required by the Supplementary Conditions. All Bonds shall be in the forms prescribed by the Contract Documents, except as otherwise provided by Laws or Regulations, and be executed by such sureties having a rating of "A" by the most recent Best's Key Rating Guide, and as are named in the current list of "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" as published in Circular 570 (amended) by the Audit Staff, Bureau of Government Financial Operations, U.S. Treasury Department. All Bonds signed by an agent must be accompanied by a certified copy of such agent's authority to act.

5.2 If the surety on any Bond furnished by CONTRACTOR is declared bankrupt or becomes insolvent or its right to do business is terminated in any state where any part of the Project is located or it ceases to meet the requirements of paragraphs 5.1, CONTRACTOR shall within ten days thereafter substitute another Bond and surety, both of which must be acceptable to OWNER.

5.3 Licensed Sureties and Insurers; Certificates of Insurance:

5.3.1 All Bonds and insurance required by the Contract Documents to be purchased and maintained by OWNER or CONTRACTOR shall be obtained from surety or insurance companies that are duly licensed or authorized in the jurisdiction in which the Project is located to issue bonds or insurance policies for the limits and coverages so required. Such surety and insurance companies shall also meet such additional requirements and qualifications as may be provided in the Supplementary Conditions.

5.3.2 CONTRACTOR shall deliver to OWNER, with copies to each additional insured indicated in the Supplementary Conditions, including ENGINEER, certificates of insurance (and other evidence of insurance requested by OWNER or any other additional insured) which CONTRACTOR is required to purchase and maintain in accordance with paragraph 5.4. OWNER shall deliver to CONTRACTOR certificates of insurance (and other evidence of insurance requested by CONTRACTOR or any other additional insured) which OWNER is required to purchase and maintain in accordance with paragraphs 5.6 and 5.7 hereof.

CONTRACTOR's Liability Insurance:

5.4 CONTRACTOR shall purchase and maintain such liability and other insurance as is appropriate for the Work being performed and furnished and as will provide protection from claims set forth below which may arise out of or result from CONTRACTOR's performance and furnishing of the Work and CONTRACTOR's other obligations under the Contract Documents, whether it is to be performed or furnished by CONTRACTOR, by any Subcontractor or Supplier, or by anyone directly or indirectly employed by any of them to perform or furnish any of the Work, or by anyone for whose acts any of them may be liable:

5.4.1 claims under workers' compensation, disability benefits and other similar employee benefit acts;

5.4.2 claims for damages because of bodily injury, occupational sickness or disease, or death of CONTRACTOR's employees;

5.4.3 claims for damages because of bodily injury, sickness or disease, or death of any person other than CONTRACTOR's employees;

5.4.4 claims for damages insured by customary personal injury liability coverage which are sustained (i) by any person as a result of an offense directly or indirectly related to the employment of such person by CONTRACTOR, or (ii) by any other person for any other reason;

5.4.5 claims for damages, other than to the Work itself because of injury to or destruction of tangible property wherever located, including loss of use resulting therefrom; and

5.4.6 claims for damages because of bodily injury or death of any person or property damage arising out of the ownership, maintenance or use of any motor vehicle.

The policies of insurance so required by this paragraph 5.4 to be purchased and maintained shall:

5.4.7 with respect to insurance required by paragraphs 5.4.3 through 5.4.6 inclusive, include as additional insureds OWNER and ENGINEER (subject to any customary exclusion in respect of professional liability) and any other persons or entities indicated in the Supplementary Conditions, all of whom shall be listed by name as additional insureds, and include coverage for the respective officers and employees of all such additional insureds;

5.4.8 include the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Law and Regulation, whichever is greater;

5.4.9 include completed operations insurance;

5.4.10 include contractual liability insurance covering CONTRACTOR's indemnity obligations under paragraphs 6.16, 6.31 and 6.32;

5.4.11 contain a provision or endorsement that the coverage afforded will not be cancelled, materially changed or renewal refused until at least 30 days prior written notice has been given to OWNER, ENGINEER and each other additional insured indicated in the Supplementary Conditions to whom a certificate of insurance had been issued (and the certificates of insurance furnished by the CONTRACTOR pursuant to paragraph 5.3.2 will so provide);

5.4.12 remain in effect at least until final payment and at all times thereafter when CONTRACTOR may be correcting, removing or replacing *defective* Work in accordance with paragraph 13.12; and

5.4.13 with respect to completed operations insurance and any other insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment (and CONTRACTOR shall furnish OWNER and any other additional insured indicated in the Supplementary Conditions to whom a certificate of insurance has been issued evidence satisfactory to OWNER and any such additional insured of continuation of such insurance at final payment and one year thereafter).

OWNER's Liability Insurance:

5.5 OWNER shall be responsible for purchasing and maintaining OWNER's own liability insurance and, at OWNER's option, may purchase and maintain such insurance as will protect OWNER against claims which may arise from operations under the Contract Documents.

Builders Risk Property Insurance:

5.6 Unless otherwise provided in the Supplementary Conditions, OWNER shall purchase and maintain "builders risk" property insurance upon the Work at the site in the amount of the full replacement cost there (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws or Regulations). This insurance shall:

5.6.1 include the interests of OWNER, CONTRACTOR, Subcontractors, ENGINEER, ENGINEER's Consultant, and any other persons or entities indicated in the Supplementary Conditions, all of whom shall be listed as insureds or additional insureds;

5.6.2 be written on a Builder's Risk "all-risk" policy form, shall at least include insurance for physical loss and damage, and shall insure against the peril of fire and extended coverage, theft, vandalism and malicious mischief, earthquake, temporary buildings, falsework, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations and water damage, and such other perils as may be provided in the Supplementary Conditions;

5.6.3 include damages, losses and expenses arising out of or resulting from any insured loss or incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers, architects, attorneys and other professionals);

5.6.4 cover materials and equipment stored on or off the site or in transit prior to being incorporated in the Work where such materials and equipment are included in an approved Application for Payment; and

5.6.5 be maintained in effect until final payment is made unless otherwise agreed to in writing by OWNER, CONTRACTOR and ENGINEER, with thirty days written notice to each other additional insured to whom a certificate of insurance has been issued.

5.7 OWNER shall purchase and maintain such boiler and machinery insurance or additional property insurance as may be required by the Supplementary Conditions or Laws and Regulations which will include the OWNER, CONTRAC-

TOR, Subcontractors, ENGINEER, ENGINEER's Consultants, and any other insureds as may be indicated in the Supplementary Conditions, all of whom shall be listed by name as insureds or additional insureds.

5.8 All the policies of insurance (or the certificates or other evidence thereof) required to be purchased and maintained by OWNER in accordance with paragraphs 5.6 and 5.7 will contain a provision or endorsement that the coverage afforded will not be cancelled or materially changed or renewal refused until at least thirty days prior written notice has been given to CONTRACTOR, and to each other additional insured to whom a certificate of insurance has been issued and will contain waiver provisions in accordance with paragraph 5.11.

5.9 OWNER shall not be responsible for purchasing and maintaining any property insurance to protect the interests of CONTRACTOR, Subcontractors or others in the Work to the extent of any deductible amounts that are identified in the Supplementary Conditions. The risk of loss within such identified deductible amount will be borne by the CONTRACTOR, Subcontractors or others suffering any such loss and if any of them wishes property insurance coverage within the limits of such amounts, each may purchase and maintain it at the purchaser's own expense.

5.10 If CONTRACTOR requests in writing that other special insurance be included in the property insurance policy, OWNER shall, if possible, include such insurance, and the cost thereof will be charged to CONTRACTOR by appropriate Change Order or Written Amendment. Prior to commencement of the Work at the site, OWNER shall in writing advise CONTRACTOR whether or not such other insurance has been procured by OWNER.

Waiver of Rights:

5.11 OWNER and CONTRACTOR intend that all policies provided in response to paragraphs 5.6 and 5.7 will protect all of the parties listed as insureds or additional insureds in such policies and provide primary coverage for all losses and damages covered by perils insured thereby. All such policies shall contain provisions to the effect that in the event of payment of any loss or damage the insurers will have no rights of recovery against any of the parties so listed. Accordingly, OWNER and CONTRACTOR waive all rights against each other for all losses and damages caused by any of the perils covered by such policies and any other property insurance applicable to the Work to the extent of insurance proceeds received under all such policies; and, in addition, waive all such rights against Subcontractors and all other parties so listed, and also against ENGINEER and ENGINEER's Consultants, for losses and damages so caused. None of the above waivers shall extend to the rights that any of the parties so listed may have to the proceeds of insurance held by OWNER as trustee or otherwise payable under any policy so issued.

Receipt and Application of Proceeds:

5.12 Any insured loss under the policies of insurance required by paragraphs 5.6 and 5.7 will be adjusted with OWNER and made payable to OWNER as fiduciary for the insureds, as their interests may appear, subject to the requirements of any applicable mortgage clause and of paragraph 5.13. OWNER shall deposit in a separate account any money so received, and shall distribute it in accordance with such agreement as the parties in interest may reach. If no other special agreement is reached the damaged Work shall be repaired or replaced, the monies so received applied on account thereof and the Work and the cost thereof covered by an appropriate Change Order or Written Amendment.

5.13 OWNER as fiduciary shall have power to adjust and settle any loss with the insurers unless one of the parties in interest shall object in writing within fifteen days after the occurrence of loss to OWNER's exercise of this power. If such objection is made, OWNER as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached, OWNER as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, OWNER as fiduciary shall give bond for the proper performance of such duties.

Acceptance of Insurance:

5.14 If OWNER has any objection to the coverage afforded by or other provisions of the Bonds or insurance required to be purchased and maintained by CONTRACTOR in accordance with paragraphs 5.1, 5.2, 5.3 and 5.4 and any applicable provisions of the Supplementary Conditions on the basis of their not complying with the Contract Documents, OWNER shall notify CONTRACTOR in writing thereof within ten days of the date of delivery of such certificates (or other evidence requested) in accordance with paragraph 2.7. If CONTRACTOR has any objection to the coverage afforded by or other provisions of the policies of insurance required to be purchased and maintained by OWNER in accordance with paragraphs 5.6 and 5.7 and any applicable provisions of the Supplementary Conditions on the basis of their not complying with the Contract Documents, CONTRACTOR shall notify OWNER in writing thereof within ten days of the date of delivery of such certificates (or other evidence requested) in accordance with paragraph 2.7. OWNER and CONTRACTOR shall each provide to the other such additional information in respect of insurance provided by each as the other may reasonably request.

Partial Utilization -- Property Insurance:

5.15 If OWNER finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work, such use or occupancy may be accomplished in accordance with paragraph 14.10; provided that no such use or occupancy shall commence before the insurers providing the property insurance have acknowledged notice thereof and in writing effected the changes in coverage necessitated thereby. The insurers providing the property insurance shall consent by endorsement on the policy or policies, but the property insurance shall not be cancelled or permitted to lapse on account

of any such partial use or occupancy.

ARTICLE 6 -- CONTRACTOR's RESPONSIBILITIES

Supervision and Superintendence:

6.1 CONTRACTOR shall supervise, inspect and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. CONTRACTOR shall be solely responsible for the means, methods, techniques, sequences and procedures of construction, but CONTRACTOR shall not be responsible for the negligence of others in the design or specification of a specific means, method, technique, sequence or procedure of construction which is indicated in and expressly required by the Contract Documents. CONTRACTOR shall be responsible to see that the completed Work complies accurately with the Contract Documents.

6.2 CONTRACTOR shall keep on the Work at all times during its progress a competent resident superintendent, who shall not be replaced without written notice to OWNER and ENGINEER except under extraordinary circumstances. The OWNER shall have the right to reject or demand replacement of such superintendent at any time, with or without cause, solely at the OWNER's discretion, based upon objective or subjective reasons, which reasons the OWNER may, but is not required to, disclose to the CONTRACTOR. The superintendent will be CONTRACTOR's representative at the site and shall have authority to act on behalf of CONTRACTOR. All communications given to the superintendent shall be as binding as if given to CONTRACTOR.

Labor, Materials and Equipment:

6.3 CONTRACTOR shall provide competent, suitably qualified personnel to survey and lay out the Work and perform construction as required by the Contract Documents. CONTRACTOR shall at all times maintain good discipline and order at the site. Except as otherwise required for the safety or protection of persons or the Work or property at the site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the site shall be performed during regular working hours, and CONTRACTOR will not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without OWNER's written consent given after prior written notice to ENGINEER.

6.4 Unless otherwise specified in the General Requirements, CONTRACTOR shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of the Work.

6.5 All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. All warranties and guarantees specifically called for by the Specifications shall expressly run to the benefit of OWNER. If required by ENGINEER, CONTRACTOR shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used, cleaned and conditioned in accordance with the instructions of the applicable Supplier, except as otherwise provided in Contract Documents.

Progress Schedule:

6.6 CONTRACTOR shall adhere to the finalized progress schedule established in accordance with paragraph 2.9, as it may be adjusted from time to time in accordance with the Contract Documents. CONTRACTOR shall submit to the ENGINEER for acceptance (to the extent indicated in paragraph 2.9) adjustments in the finalized progress schedule to reflect the impact thereon of new developments. Such adjustments will conform generally to the progress schedule then in effect and additionally will comply with any provisions of the General Requirements applicable thereto.

Substitutes and "Or-Equal" Items:

6.7 Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, no like, equivalent, or "or equal" item or substitution is permitted.

6.8 Concerning Subcontractors, Suppliers and Others:

6.8.1 CONTRACTOR shall not employ any Subcontractor, Supplier or other person or organization (including those acceptable to OWNER and ENGINEER as indicated in paragraph 6.8.2) whether initially or as a substitute, against whom OWNER or ENGINEER may have reasonable objection. CONTRACTOR shall not be required to employ any Subcontractor, Supplier or other person or organization to furnish or perform any of the Work against whom CONTRACTOR has reasonable objection.

6.8.2 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers or other persons or organizations (including those who are to furnish the principal items of materials and equipment) to be submitted to OWNER in advance of the specified date prior to the Effective Date of the Agreement for acceptance by OWNER and ENGINEER and if CONTRACTOR has submitted a list thereof in accordance with the Supplementary Conditions, OWNER's or ENGINEER's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the bidding documents or the Contract Documents) of any such Subcontractor, Supplier or other person or organization so identified may be revoked on the basis of

reasonable objection after due investigation, in which case CONTRACTOR shall submit an acceptable substitute. The Contract Price or Contract Times will be adjusted by the difference in the cost or time occasioned by such substitution and an appropriate Change Order will be issued or Written Amendment signed. No acceptance by OWNER or ENGINEER of any such Subcontractor, Supplier or other person or organization shall constitute a waiver of any right of OWNER or ENGINEER to reject *defective* Work.

6.9 CONTRACTOR Responsible for Subcontractors:

6.9.1 CONTRACTOR shall be fully responsible to OWNER and ENGINEER for all acts and omissions of the Subcontractors, Suppliers, and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR, just as CONTRACTOR is responsible for CONTRACTOR's own acts and omissions. Nothing in the Contract Documents shall create for the benefit of any such Subcontractor, Supplier or other person or organization any contractual relationship between OWNER or ENGINEER and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of OWNER or ENGINEER to pay or to see to the payment of any moneys due any such Contractor, Supplier, or other person or organization except as may otherwise be required by Laws or Regulations.

6.9.2 CONTRACTOR shall be fully responsible for scheduling and coordinating the Work of Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with CONTRACTOR. CONTRACTOR shall require any Subcontractor, Suppliers or other persons and organizations performing or furnishing any of the Work to communicate with the ENGINEER through CONTRACTOR.

6.10 The divisions and sections of the Specifications and the identification of any Drawings shall not control CONTRACTOR in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

6.11 All Work performed for CONTRACTOR by a Subcontractor or Supplier will be pursuant to an appropriate agreement between CONTRACTOR and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of OWNER and ENGINEER. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in paragraph 5.6 or 5.7, the agreement between the CONTRACTOR and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against OWNER, CONTRACTOR, ENGINEER, ENGINEER's Consultants and all other additional insureds for all losses and damages caused by any of the perils covered by such policies and any other property insurance applicable to the Work. If the insurers on any such policies require separate waiver forms to be signed by any Subcontractor or Supplier, CONTRACTOR will obtain the same.

Patent Fees and Royalties:

6.12 CONTRACTOR shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of OWNER or ENGINEER its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by OWNER in the Contract Documents. CONTRACTOR shall idemnify and hold harmless and defend OWNER and ENGINEER and ENGINEER's Consultants and anyone directly or indirectly employed by any of them from and against all claims, damages, losses and expenses (including but not limited to fees of engineers, architects, attorneys, and other professionals, and court and arbitration costs) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the Work or resulting from the incorporation in the Work of any invention, design, process, product or device not specified in the Contract Documents.

Permits:

6.13 Unless otherwise provided in the Supplementary Conditions, CONTRACTOR shall obtain and pay for all construction permits and licenses. OWNER shall assist CONTRACTOR, when necessary, in obtaining such permits and licenses. CONTRACTOR shall pay all governmental charges and inspection fees necessary for the prosecution of the Work, which are applicable at the time of opening of Bids, or if there are no Bids, on the Effective Date of the Agreement. CONTRACTOR shall pay all charges of utility owners for connections to the Work, and OWNER shall pay all charges of such utility owners for capital costs related thereto such as plant investment fees.

6.14 Laws and Regulations:

6.14.1 CONTRACTOR shall give all notices and comply with all Laws and Regulations applicable to furnishing and performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, neither OWNER nor ENGINEER shall be responsible for monitoring CONTRACTOR's compliance with any Laws or Regulations.

6.14.2 If CONTRACTOR performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, CONTRACTOR shall bear all costs arising therefrom; however, it shall not be CONTRACTOR's primary responsibility to make certain that the Specifications and Drawings are in accordance with such Laws and

Regulations, but this shall not relieve CONTRACTOR of CONTRACTOR's obligations under paragraph 3.3.2.

Taxes:

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

Use of Premises:

6.16 CONTRACTOR shall confine construction equipment, the storage of materials and equipment and the operations of workers to the site and land and areas identified in and permitted by the Contract Documents and other land and areas permitted by Laws and Regulations, rights-of-way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. CONTRACTOR shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any adjacent land or areas, resulting from the performance of the Work. Should any claim be made against OWNER or ENGINEER by any such owner or occupant because of the performance of the Work, CONTRACTOR shall promptly attempt to settle with such other party by agreement or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law. CONTRACTOR shall, to the fullest extent permitted by Laws and Regulations, idemnify, hold harmless and defend OWNER, ENGINEER and ENGINEER's Consultants and anyone directly or indirectly employed by any of them from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any such other party against OWNER, ENGINEER or ENGINEER's Consultant to the extent caused by or based upon CONTRACTOR's performance of the Work.

6.17 During the progress of the Work, CONTRACTOR shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. At the completion of the Work CONTRACTOR shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the site clean and ready for occupancy by OWNER at Substantial Completion of the Work. CONTRACTOR shall restore to original condition all property not designated for alteration by the Contract Documents.

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

Record Documents:

6.19 CONTRACTOR shall maintain in a safe place at the site one record copy of all Drawings, Specifications, Addenda, Written Amendments, Change Orders, Work Change Directives, Field Orders and written interpretations and clarifications (issued pursuant to paragraph 9.4) in good order and annotated to show all changes made during construction. These record documents together with all approved Samples and a counterpart of all approved Shop Drawings will be available to ENGINEER for reference. Upon completion of the Work, these record documents, Samples and Shop Drawings will be delivered to ENGINEER for OWNER.

Safety and Protection:

6.20 CONTRACTOR shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work. CONTRACTOR shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury or loss to:

6.20.1 all persons on the Work who may be affected by the Work;

6.20.2 all the Work and materials and equipment to be incorporated therein, whether in storage on or off the site; and

6.20.3 other property at the site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities and Underground Facilities not designed for removal, relocation or replacement in the course of construction.

CONTRACTOR shall comply with all applicable Laws and Regulations of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. CONTRACTOR shall notify owners of adjacent property and of Underground Facilities and utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation and replacement of their property. All damage, injury or loss to any property referred to in paragraph 6.20.2 or 6.20.3 caused, directly or indirectly, in whole or in part, by CONTRACTOR, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, shall be remedied by CONTRACTOR (except damage or loss attributable to the fault of Drawings or Specifications or to the acts or omissions of OWNER or ENGINEER or ENGINEER's Consultant or anyone employed by any of them or anyone for whose acts any of them may be liable, and not attributable, directly or indirectly, in whole or in part, to the fault or negligence of CONTRACTOR or any Subcontractor, Supplier or other person or organization directly or indirectly employed by any of them). CONTRACTOR's duties and responsibilities for safety and the protection of the Work shall continue until such time as all the Work is completed and ENGINEER has issued a notice to OWNER and CONTRAC-

TOR in accordance with paragraph 14.13 that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

6.21 Safety Representative: CONTRACTOR shall designate an experienced safety representative at the site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

6.22 In performing the Work, CONTRACTOR shall take all measures to prevent the release, spillage or improper disposal of any hazardous substance or construction or waste materials which may contaminate the OWNER's or adjacent properties or the environment or substantially endanger human health. The transportation, handling, storage and use of gasoline, oils, paints, residual cleaning solvents and other hazardous substances or contaminating materials by CONTRACTOR or any Subcontractor shall be in such a manner to prevent release, spillage or improper disposal. Should any such hazardous substances or contaminating materials be released, spilled or improperly disposed of by the CONTRACTOR or any Subcontractors, the CONTRACTOR shall immediately notify the OWNER and ENGINEER, notify any applicable environmental agency as required by Laws and Regulations, and immediately remedy or remove such substances or materials, and clean and restore the affected areas to a safe condition and to the satisfaction of the OWNER and any applicable environmental agency. The CONTRACTOR shall pay all costs for the remedy or removal of contaminate materials and the proper disposal of them at an approved and permitted site and the restoration of the affected areas. The CONTRACTOR shall also be responsible for the payments of and shall indemnify, hold harmless and defend the OWNER, ENGINEER and ENGINEER's Consultant from all penalties, fines and damage claims resulting from the release, spillage or improper disposal by CONTRACTOR or any Subcontractor of any such hazardous substances or contaminating material.

Emergencies:

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

Shop Drawings and Samples:

6.24 CONTRACTOR shall submit:

6.24.1 Shop Drawings to ENGINEER for review and approval in accordance with the accepted schedule of Shop Drawings and Sample submittals (see paragraph 2.9). All submittals will be identified as ENGINEER may require and in the number of copies specified in the General Requirements. The data shown on the Shop Drawings will be complete with respect to quantities, dimensions, specified performance and design criteria, materials and similar data to show ENGINEER the materials and equipment CONTRACTOR proposes to provide and to enable ENGINEER to review the information for the limited purposes required by paragraph 6.26.

6.24.2 Samples to ENGINEER for review and approval in accordance with said accepted schedule of Shop Drawings and Sample submittals. Each Sample will be identified clearly as to material, Supplier, pertinent data such as catalog numbers and the use for which intended and otherwise as ENGINEER may require to enable ENGINEER to review the submittal for the limited purposes required by paragraph 6.26. The numbers of each Sample to be submitted will be as specified in the Specifications.

6.25 *Verification and Notice of Variations:*

6.25.1 Before submitting each Shop Drawing or Sample, CONTRACTOR shall have determined and verified (i) all field measurements, quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar information with respect thereto, (ii) all materials with respect to intended use, fabrication, shipping, handling, storage, assembly and installation pertaining to the performance of the Work, and (iii) all information relative to CONTRACTOR's sole responsibilities in respect of means, methods, techniques, sequences and procedures of construction and safety precautions and programs incident thereto. CONTRACTOR shall also have reviewed and coordinated each Shop Drawing or Sample with other Shop Drawings and Samples and with the requirements of the Work and the Contract Documents.

6.25.2 Each submittal will bear a stamp or specific written indication that CONTRACTOR has satisfied CONTRACTOR's obligations under the Contract Documents with respect to CONTRACTOR's review and approval of that submittal.

6.25.3 At the time of each submission, CONTRACTOR shall give ENGINEER specific written notice of such variations, if any, that the Shop Drawing or Sample submitted may have from the requirements of the Contract Documents, such notice to be in a written communication separate from the submittal; and, in addition, shall cause a specific notation to be made on each Shop Drawing and Sample submitted to ENGINEER for review and approval of each such variation.

6.26 ENGINEER will review and approve Shop Drawings and Samples in accordance with the final schedule of Shop Drawings and Sample submittals accepted by ENGINEER as

required by paragraph 2.9. ENGINEER's review and approval will be only to determine if the items covered by the submittals will, after installation or incorporation in the Work, conform to the information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. ENGINEER's review and approval will not extend to means, methods, techniques, sequences or procedures of construction (except where a specific means, method, technique, sequence or procedure of construction is specifically and expressly called for by the Contract Documents) or to safety precautions or programs incident thereto. The review and approval of a separate item as such will not indicate approval of the assembly in which the item functions. CONTRACTOR shall make corrections required by ENGINEER, and shall return the required number of corrected copies of Shop Drawings and submit as required new Samples for review and approval. CONTRACTOR shall direct specific attention in writing to revisions other than the corrections called for by ENGINEER on previous submittals.

6.27 ENGINEER's review and approval of Shop Drawings or Samples shall not relieve CONTRACTOR from responsibility for any variation from the requirements of the Contract Documents unless CONTRACTOR has in writing called ENGINEER's attention to each such variation at the time of submission as required by paragraph 6.25.3 and ENGINEER has given written approval of each such variation by a specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample approval; nor will any approval by ENGINEER relieve CONTRACTOR from responsibility for complying with the requirements of paragraph 6.25.1.

6.28 Where a Shop Drawing or Sample is required by the Contract Documents or the final schedule of Shop Drawings and Sample submissions accepted by ENGINEER as required by paragraph 2.9, any related Work performed prior to ENGINEER's review and approval of the pertinent submittal will be at the sole expense and responsibility of CONTRACTOR.

Continuing the Work:

6.29 CONTRACTOR shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with OWNER. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by paragraph 15.5 or as CONTRACTOR and OWNER may otherwise agree in writing.

6.30 CONTRACTOR's General Warranty and Guarantee

6.30.1 CONTRACTOR warrants and guarantees to OWNER, ENGINEER and ENGINEER's Consultants that all Work will be in accordance with the Contract Documents and will not be *defective*.

6.30.2 CONTRACTOR's obligation to perform and complete the Work in accordance with the Contract Documents shall be absolute and unconditional. None of the following will constitute an acceptance of Work that is not in accordance with the Contract Documents or a release of CONTRACTOR's obligation to perform the Work in accordance with the Contract Documents:

6.30.2.1 observations by ENGINEER;

6.30.2.2 recommendation of any progress or final payment by ENGINEER;

6.30.2.3 the issuance of a certificate of Substantial Completion or any payment by OWNER to CONTRACTOR under the Contract Documents;

6.30.2.4 any use or occupancy of the Work or any part thereof by OWNER;

6.30.2.5 any act or acceptance by OWNER or any failure to do so;

6.30.2.6 any review and approval of a Shop Drawing or Sample submittal, or the issuance of a notice of acceptability by ENGINEER pursuant to paragraph 14.13; or

6.30.2.7 any inspection, test or approval by others; or

6.30.2.8 any correction of *defective* Work by OWNER.

6.31 *Indemnification:*

6.31.1 To the fullest extent permitted by Laws and Regulations CONTRACTOR shall indemnify and hold harmless OWNER, ENGINEER, ENGINEER's Consultant and the affiliated companies, consultants, agents, officers, directors and employees of each and any of them from and against all claims, damages, losses and expenses, direct, indirect or consequential (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs) arising out of or resulting from the performance of the Work, provided that any such claim, damage, loss or expense (a) is attributable to bodily injury, personal injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself) including the loss of use resulting therefrom and (b) is caused in whole or in part by any negligent act or omission of CONTRACTOR, any Subcontractor, any Supplier, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, regardless of whether or not caused in part by any negligence or omission of a person or entity indemnified hereunder or whether liability is imposed upon such indemnified party by Laws and Regulations regardless of the negligence of any such person or entity.

6.31.2 In any and all claims against OWNER, ENGINEER, ENGINEER's Consultant or the affiliated companies, consultants, agents, officers, directors, or employees of each or any of them by any employee (or the survivor or personal representative of such employee) of CONTRACTOR, any Subcontractor, any Supplier, any

person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, the indemnification obligation under paragraph 6.31 shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for CONTRACTOR or any such Subcontractor, Supplier or other person or organization under workers' compensation acts, disability benefit acts or other employee benefit acts.

6.31.3 If any provisions of paragraphs 6.31 or 6.32 in respect of indemnification is prohibited or unenforceable by applicable law, then said paragraphs 6.31 and 6.32, as applicable, shall be reformed and amended so that the parties indemnified hereunder are provided with the fullest extent of indemnification as is permitted under applicable law and the remainder of the Contract Documents shall remain in full force and effect and not be invalidated.

6.32 *Survival of Obligations:*

All representations, indemnifications, warranties and guarantees made in, required by, or given in accordance with the Contract Documents will survive final payment, completion and acceptance of the Work and termination or completion of the Agreement.

ARTICLE 7 -- OTHER WORK

Related Work at Site:

7.1 OWNER may perform other work related to the Project at the site by OWNER's own forces, or let other direct contracts therefor which shall contain General Conditions similar to these, or have other Work performed by utility owners. If the fact that such other Work is to be performed was not noted in the Contract Documents, then (i) written notice thereof will be given to CONTRACTOR prior to starting any such other Work and (ii) CONTRACTOR may make a claim therefor as provided in Articles 11 and 12 if CONTRACTOR believes that such performance will involve additional expense to CONTRACTOR or requires additional time and the parties are unable to agree as to the amount or extent thereof.

7.2 CONTRACTOR shall afford each other contractor who is a party to such a direct contract and each utility owner (and OWNER, if OWNER is performing the additional Work with OWNER's employees) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such work and shall properly connect and coordinate the Work with theirs. Unless otherwise provided in the Contract Documents, CONTRACTOR shall do all cutting, fitting and patching of the Work that may be required to make its several parts come together properly and integrate with such other work. CONTRACTOR shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of ENGINEER and the others whose work will be affected. The duties and responsibilities of CONTRACTOR under this paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of CONTRACTOR in said direct contracts between OWNER and such utility owners and other contractors.

7.3 If the proper execution or results of any part of CONTRACTOR's Work depends upon work performed by others under this Article 7, CONTRACTOR shall inspect such other work and promptly report to ENGINEER in writing any delays, defects or deficiencies in such work that render it unavailable or unsuitable for the proper execution and results of CONTRACTOR's Work. CONTRACTOR's failure so to report will constitute an acceptance of the other work as fit and proper for integration with CONTRACTOR's Work except for latent or nonapparent defects and deficiencies in such other work.

Coordination:

7.4 If OWNER contracts with others for the performance of other work on the Project at the site, the following will be set forth in Supplementary Conditions:

7.4.1 the person, firm or corporation who will have authority and responsibility for coordination of the activities among the various prime contractors will be identified;

7.4.2 the specific matters to be covered by such authority and responsibility will be itemized; and

7.4.3 the extent of such authority and responsibilities will be provided. Unless otherwise provided in the Supplementary Conditions, OWNER shall have sole authority and responsibility in respect of such coordination.

ARTICLE 8 -- OWNER's RESPONSIBILITIES

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

8.2 In case of termination of the employment of ENGINEER's Consultant, OWNER may appoint a replacement whose status under the Contract Documents shall be that of the former ENGINEER's Consultant.

8.3 OWNER shall furnish the data required of OWNER under the Contract Documents promptly and shall make payments to CONTRACTOR promptly after they are due as provided in paragraphs 14.4 and 14.13.

8.4 OWNER's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in paragraphs 4.1 and 4.4. Paragraph 4.2 refers to OWNER identifying and making available to CONTRACTOR copies of reports of explorations and tests of subsurface conditions at the site and drawings of

physical conditions in or relating to existing structures which have been utilized by ENGINEER in preparing the Drawings and Specifications.

8.5 OWNER's responsibilities in respect of purchasing and maintaining liability and property insurance are set forth in paragraphs 5.5 through 5.10.

8.6 OWNER is obligated to execute Change Orders as indicated in paragraph 10.4.

8.7 OWNER's responsibility in respect of certain inspections, tests and approvals is set forth in paragraph 13.4.

8.8 In connection with OWNER's right to stop Work or suspend Work, see paragraphs 13.10 and 15.1. Paragraph 15.2 deals with OWNER's right to terminate services of CONTRACTOR under certain circumstances.

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

8.10 OWNER's responsibility in respect of undisclosed Asbestos, PCBs, Petroleum, Hazardous Waste or Radioactive Material uncovered or revealed at the site is set forth in paragraph 4.5.

ARTICLE 9 -- ENGINEER's STATUS

9.1 *OWNER's Representative:*

9.1.1 ENGINEER will be OWNER's representative during the construction period. The duties and responsibilities and the limitations of authority of ENGINEER as OWNER's representative during construction are set forth in the Contract Documents and shall not be extended without written consent of OWNER and ENGINEER.

9.1.2 The assignment of any authority, duties or responsibilities to ENGINEER under the Contract Documents, or any undertaking, exercise or performance thereof by ENGINEER, is intended to be for the sole and exclusive benefit of OWNER and not for the benefit of CONTRACTOR, Subcontractor, Supplier or any other person or organization.

Visits to Site:

9.2 Subject to the limitations of authority and responsibilities indicated in paragraph 9.13, ENGINEER will make visits to the site at intervals appropriate to the various stages of construction as ENGINEER deems necessary in order to observe as an experienced and qualified design professional the progress that has been made and the quality of the various aspects of CONTRACTOR's executed Work. Based on information obtained during such visits and observations, ENGINEER will endeavor for the benefit of OWNER to determine, in general, if the Work is proceeding in accordance with the Contract Documents. ENGINEER will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. ENGINEER's efforts will be directed toward providing for OWNER a greater degree of confidence that the completed Work will conform generally to the Contract Documents. On the basis of such visits and on-site observations, ENGINEER will keep OWNER informed of the progress of the Work and will endeavor to guard OWNER against *defective* Work. ENGINEER will not supervise, direct or have control over any of CONTRACTOR's Work during such visits or as a result of such observations of CONTRACTOR's Work.

Project Representative:

9.3 If OWNER and ENGINEER agree, ENGINEER will furnish a Resident Project Representative to assist ENGINEER in providing more continuous observation of the Work. The duties, responsibilities and limitations of authority of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions. If OWNER designates another agent to represent OWNER at the site who is not ENGINEER's agent or employee, the duties, responsibilities and limitations of authority of such other person will be as provided in the Supplementary Conditions.

Clarifications and Interpretations:

9.4 ENGINEER will issue with reasonable promptness such written clarifications or interpretations of the requirements of the Contract Documents (in the form of Drawings or otherwise) as ENGINEER may determine necessary which shall be consistent with the intent of and reasonably inferable from the Contract Documents. Such written clarifications and interpretations will be binding on OWNER and CONTRACTOR. If CONTRACTOR or OWNER believes that a written clarification or interpretation justifies an adjustment in the Contract Price or an adjustment, if any, of the Contract Times and the parties are unable to agree to the amount or extent thereof, CONTRACTOR or OWNER may make a claim therefor as provided in Article 11 or Article 12. All requests from CONTRACTOR for clarification or interpretation shall be submitted to ENGINEER in writing.

Authorized Variations in Work:

9.5 ENGINEER may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Times and are compatible with the design concept of the complete project as a functioning whole as indicated by the Contract Documents. These may be accomplished by a Field Order and will be binding on OWNER and also on CONTRACTOR who shall perform the Work involved promptly. If CONTRACTOR or OWNER believes

that a Field Order justifies an adjustment in the Contract Price or an extension of the Contract Times and the parties are unable to agree as to the amount or extent thereof, CONTRACTOR or OWNER may make a claim therefor as provided in Article 11 or 12.

Rejecting Defective Work:

9.6 ENGINEER will have authority to disapprove or reject Work which ENGINEER believes to be *defective* or that ENGINEER believes will not produce a completed Project that conforms to the Contract Documents or that will prejudice the integrity of the design concept of the completed Project as a functioning whole as indicated by the Contract Documents. ENGINEER will also have authority to require special inspection or testing of the Work as provided in paragraph 13.9, whether or not the Work is fabricated, installed or completed.

Shop Drawings, Change Orders and Payments:

9.7 In connection with ENGINEER's authority as to Shop Drawings and Samples, see paragraphs 6.24 through 6.28 inclusive.

9.8 In connection with ENGINEER's authority as to Change Orders, see Articles 10, 11 and 12.

9.9 In connection with ENGINEER's authority as to Applications for Payment, see Article 14.

Determinations for Unit Prices:

9.10 ENGINEER will determine the actual quantities and classifications of Unit Price Work performed by CONTRACTOR. ENGINEER will review with CONTRACTOR ENGINEER's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Appeal in accordance with paragraph 9.12 will not be subject to procedures of paragraph 9.11.

Decisions on Disputes:

9.11 Claims, disputes and other matters relating to the acceptability of the Work or the interpretation of the requirements of the Contract Documents pertaining to the performance and furnishing of the Work and claims under Articles 11 and 12 in respect of changes in the Contract Price or Contract Times will be referred initially to ENGINEER in writing with a request for a formal decision in accordance with this paragraph. Written notice of each such claim, dispute and other matter will be delivered by the claimant to ENGINEER and the other party to the Agreement promptly (but in no event later than thirty days) after the start of the occurrence or event giving rise thereto, and written supporting data will be submitted to ENGINEER and the other party within sixty days after the start of such occurrence or event unless ENGINEER allows an additional period of time for the submission of additional or more accurate data in support of such claim, dispute or other matter. The opposing party shall submit any response to ENGINEER and the claimant within thirty days after receipt of the claimant's last submittal (unless ENGINEER allows additional time). ENGINEER will render a formal decision in writing within a reasonable time after receipt of the opposing party's submittal, if any, in accordance with this paragraph.

9.12 ENGINEER's written decisions pursuant to paragraphs 9.10 and 9.11 will be final and binding upon OWNER and CONTRACTOR, unless, within ten days after the date of any such decision, either OWNER or CONTRACTOR delivers to the other party to the Agreement and to ENGINEER written notice of intention to appeal ENGINEER's decision. Delivery of such written notice of intention to appeal a decision by ENGINEER pursuant to paragraphs 9.10 or 9.11 with respect to any claim, dispute or other matter (except any which have been waived by the making or acceptance of final payment as provided in paragraph 14.15) will be a condition precedent to any exercise by OWNER or CONTRACTOR of such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any such claim, dispute or other matter pursuant to Article 16. OWNER and CONTRACTOR agree to defer the exercise of their respective rights and remedies under Article 16 with respect to any claim, dispute or other matter that is the subject of such notice of intention to appeal until the making and acceptance of final payment, unless such deferral would irrevocably prejudice the rights of OWNER or CONTRACTOR. OWNER and CONTRACTOR intend to attempt to negotiate a settlement of any outstanding claims at or before the making and acceptance of final payment.

9.13 Limitations on ENGINEER's Authority and Responsibilities

9.13.1 Neither ENGINEER's responsibility or authority to act under this Article 9 or under any other provision of the Contract Documents or under any agreement between OWNER and ENGINEER or OWNER and ENGINEER's Consultant nor any decision made by ENGINEER in good faith either to exercise or not exercise such authority or responsibility or the undertaking, exercise or performance of any authority or responsibility by ENGINEER shall create, impose or give rise to any duty owed by ENGINEER to CONTRACTOR, any Subcontractor, any Supplier, or any other person or organization, or to any surety, or employee or agent for any of them.

9.13.2 ENGINEER will not supervise, direct, control or have authority over or be responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of the Work. ENGINEER will not be responsible for CONTRACTOR's failure to perform or furnish the Work in accordance with the Contract Documents.

9.13.3 ENGINEER will not be responsible for the acts or omissions of CONTRACTOR or of any Subcontractor, any

Suppliers, or of any other person or organization performing or furnishing any of the Work.

9.13.4 ENGINEER will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. When functioning as initial interpreter and judge, ENGINEER will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

ARTICLE 10 -- CHANGES IN THE WORK

10.1 Without invalidating the Agreement and without notice to any surety, OWNER may, at any time or from time to time, order additions, deletions or revisions in the Work. Such additions, deletions or revisions will be authorized by a Written Amendment, a Change Order, or a Work Change Directive. Upon receipt of any such document, CONTRACTOR shall promptly proceed with the Work involved which will be performed under the applicable conditions of the Contract Documents (except as otherwise specifically provided).

10.2 If OWNER and CONTRACTOR are unable to agree as to the extent, if any, of an adjustment in the Contract Price or an adjustment of the Contract Times that should be allowed as a result of a Work Change Directive, a claim may be made therefor as provided in Article 11 and Article 12.

10.3 CONTRACTOR shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any Work performed that is not required by the Contract Documents as amended, modified and supplemented as provided in paragraphs 3.5 and 3.6, except in the case of an emergency as provided in paragraph 6.23 or in the case of uncovering Work as provided in paragraph 13.9.

10.4 OWNER and CONTRACTOR shall execute appropriate Change Orders recommended by ENGINEER (or Written Amendments) covering:

10.4.1 changes in the Work which are (i) ordered by OWNER pursuant to paragraph 10.1, (ii) required because of acceptance of *defective* Work under paragraph 13.13 or correcting *defective* Work under paragraph 13.14, or (iii) agreed to by the parties;

10.4.2 changes in the Contract Price or Contract Times which are agreed to by the parties; and

10.4.3 changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by ENGINEER pursuant to paragraph 9.11;

provided that in lieu of executing any such Change Order, an appeal may be taken from any such decision in accordance with the provisions of the Contract Documents and applicable Laws and Regulations, but during any such appeal, CONTRACTOR shall carry on the Work and adhere to the progress schedule as provided in paragraph 6.29.

10.5 If notice of any change affecting the general scope of the Work or the provisions of the Contract Documents (including but not limited to, Contract Price or Contract Times) is required by the provisions of any Bond to be given to a surety, the giving of any such notice will be CONTRACTOR's responsibility, and the amount of each applicable Bond will be adjusted accordingly.

ARTICLE 11 -- CHANGE OF CONTRACT PRICE

11.1 The Contract Price constitutes the total compensation (subject to authorized adjustments) payable to CONTRACTOR for performing the Work. All duties, responsibilities and obligations assigned to or undertaken by CONTRACTOR shall be at CONTRACTOR's expense without change in the Contract Price.

11.2 The Contract Price may only be changed by a Change Order or by a Written Amendment. Any claim for an adjustment in the Contract Price shall be based on written notice delivered by the party making the claim to the other party and to ENGINEER promptly (but in no event later than thirty days) after the start of the occurrence or event giving rise to the claim and stating the general nature of the claim. Notice of the amount of the claim with supporting data shall be delivered within sixty days after such start of the occurrence or event (unless ENGINEER allows additional time for claimant to submit additional or more accurate data in support of the claim) and shall be accompanied by claimant's written statement that the amount claimed covers all known amounts (direct, indirect and consequential) to which the claimant is entitled as a result of said occurrence or event. All claims for adjustment in the Contract Price shall be determined by ENGINEER in accordance with paragraph 9.11 if OWNER and CONTRACTOR cannot otherwise agree on the amount involved. No claim for an adjustment in the Contract Price will be valid if not submitted in accordance with this paragraph 11.2.

11.3 The value of any Work covered by a Change Order or of any claim for an adjustment in the Contract Price will be determined as follows:

11.3.1 where the Work involved is covered by unit prices contained in the Contract Documents, by application of such unit prices to the quantities of the items involved (subject to the provisions of paragraphs 11.9.1 through 11.9.3 inclusive);

11.3.2 where the Work involved is not covered by unit prices contained in the Contract Documents, by a mutually agreed lump sum (which may include an allowance for overhead and profit). Such allowance shall not exceed a fee calculated in accordance with paragraph 11.6.2.

11.3.3 where the Work involved is not covered by unit prices contained in the Contract Documents and agreement to a lump sum is not reached under paragraph 11.3.2, on the basis of the Cost of the Work (determined as provided in paragraphs 11.4 and 11.5) plus a CONTRACTOR's fee for overhead and

profit (determined as provided in paragraph 11.6).

Cost of the Work:

11.4 The term Cost of the Work means the sum of all costs necessarily incurred and paid by CONTRACTOR in the proper performance of the Work. Except as otherwise may be agreed to in writing by OWNER, such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall include only the following items and shall not include any of the costs itemized in paragraph 11.5.

11.4.1 Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by OWNER and CONTRACTOR. Such employees shall include without limitation superintendents, foremen and other personnel employed full-time at the site. Payroll costs for employees not employed full-time on the Work shall be apportioned on the basis of their time spent on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits which shall include social security contributions, unemployment, excise and payroll taxes, workers' compensation, health and retirement benefits, bonuses, sick leave, vacation and holiday pay applicable thereto. The expenses of performing Work after regular working hours, on Saturday, Sunday or legal holidays, shall be included in the above to the extent authorized by OWNER.

11.4.2 Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage thereof, and Suppliers' field services required in connection therewith. All cash discounts shall accrue to CONTRACTOR unless OWNER deposits funds with CONTRACTOR with which to make payments, in which case the cash discounts shall accrue to OWNER. All trade discounts, rebates and refunds and all returns from sale of surplus materials and equipment shall accrue to OWNER, and CONTRACTOR shall make provisions so that they may be obtained.

11.4.3 Payments made by CONTRACTOR to the Subcontractors for Work performed or furnished by Subcontractors. If required by OWNER, CONTRACTOR shall obtain competitive bids from subcontractors acceptable to OWNER and CONTRACTOR and shall deliver such bids to OWNER who will then determine, with the advice of ENGINEER, which bids, if any, will be accepted. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as CONTRACTOR's Cost of the Work and fee as provided in paragraphs 11.4, 11.5, 11.6 and 11.7. All Subcontractors shall be subject to the other provisions of the Contract Documents insofar as applicable.

11.4.4 Costs of special consultants (including but not limited to engineers, architects, testing laboratories, surveyors, attorneys and accounts) employed for services specifically related to the work, only to the extent authorized and approved in writing by the ENGINEER.

11.4.5 Supplemental costs including the following:

11.4.5.1 The proportion of necessary transportation, travel, and subsistence expenses of CONTRACTOR's employees incurred in discharge of duties connected with the Work.

11.4.5.2 Cost, including transportation and maintenance, of all materials, supplies, equipment, machinery, appliances, office and temporary facilities at the site and hand tools not owned by the workers, which are consumed in the performance of the Work, and cost less market value of such items used but not consumed which remain the property of CONTRACTOR.

11.4.5.3 Rentals of all construction equipment and machinery and the parts thereof whether rented from CONTRACTOR or others in accordance with rental agreements approved by OWNER with the advice of ENGINEER, and the costs of transportation, loading, unloading, installation, dismantling and removal thereof all in accordance with the terms of said rental agreements. The rental of any such equipment, machinery or parts shall cease when the use thereof is no longer necessary for the Work.

11.4.5.4 Sales, consumer, use or similar taxes related to the Work, and for which CONTRACTOR is liable, imposed by Laws and Regulations.

11.4.5.5 Deposits lost for causes other than negligence of CONTRACTOR, any Subcontractor or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, and royalty payments and fees for permits and licenses.

11.4.5.6 Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by CONTRACTOR in connection with the performance and furnishing of the Work (except losses and damages within the deductible amounts of property insurance established by OWNER in accordance with paragraph 5.9), provided they have resulted from causes other than the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of OWNER. No such losses, damages and expenses shall be included in the Cost of the Work for the purpose of determining CONTRACTOR's fee. If, however, any such loss or damage requires reconstruction and CONTRACTOR is placed in charge thereof, CONTRACTOR shall be paid for services a fee proportionate to that stated in paragraph 11.6.2.

11.4.5.7 The cost of utilities, fuel and sanitary facilities at the site.

11.4.5.8 Minor expenses such as telegrams, long distance telephone calls, telephone service at the site, express delivery and similar petty cash items in connection

with the Work.

11.4.5.9 Cost of premiums for additional Bonds and insurance required because of changes in the Work.

11.5 The term Cost of the Work shall not include any of the following:

11.5.1 Payroll costs and other compensation of CONTRACTOR's officers, executives, principals (of partnership and sole proprietorships), general managers, project managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks and other personnel employed by CONTRACTOR whether at the site or in CONTRACTOR's principal or a branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in paragraph 11.4.1 or specifically covered by paragraph 11.4.4 all of which are to be considered administrative costs covered by the CONTRACTOR's fee.

11.5.2 Expenses of CONTRACTOR's principal and branch offices other than CONTRACTOR's office at the site.

11.5.3 Any part of CONTRACTOR's capital expenses, including interest on CONTRACTOR's capital employed for the Work and charges against CONTRACTOR for delinquent payments.

11.5.4 Cost of premiums for all Bonds and for all insurance whether or not CONTRACTOR is required by the Contract Documents to purchase and maintain the same (except for the cost of premiums covered by subparagraph 11.4.5.9 above).

11.5.5 Costs due to the negligence of CONTRACTOR, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable, including but not limited to, the correction of *defective* Work, disposal of materials or equipment wrongly supplied and making good any damage to property.

11.5.6 Other overhead or general expense costs of any kind.

11.5.7 The costs of any item not specifically and expressly included in paragraph 11.4.

CONTRACTOR's Fee:

11.6 The CONTRACTOR's fee allowed to CONTRACTOR for overhead and profit shall be determined as follows:

11.6.1 a mutually acceptable fixed fee; or

11.6.2 if a fixed fee is not agreed upon, then a fee based on the following percentages of the various portions of the Cost of the Work:

11.6.2.1 for costs incurred under paragraphs 11.4.1 and 11.4.2 the CONTRACTOR's Fee shall be fifteen percent;

11.6.2.2 for costs incurred under paragraph 11.4.3 the CONTRACTOR's fee shall be five percent;

11.6.2.3 where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of paragraphs 11.4.1, 11.4.2, 11.4.3 and 11.6.2 is that the Subcontractor who actually performs or furnishes the Work, at whatever tier, will be paid a fee of fifteen percent of the costs incurred by such Subcontractor under paragraphs 11.4.1 and 11.4.2 and that any higher tier Subcontractor and CONTRACTOR will each be paid a fee of five percent of the amount paid to the next lower tier Subcontractor, for example:

Cost of the Work Performed by Sub-Subcontractor	= $10,000.00
Sub-Subcontractor's Fee (15 percent)	1,500.00
Total to Sub-Subcontractor	$11,500.00
Subcontractor's Fee (5 percent)	575.00
Subtotal	$12,075.00
CONTRACTOR's Fee (5 percent)	603.75
Total Change Order	= $12,678.75

11.6.2.4 no fee shall be payable on the basis of costs itemized under paragraphs 11.4.4, 11.4.5 and 11.5;

11.6.2.5 the amount of credit to be allowed by CONTRACTOR or OWNER for any such change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in CONTRACTOR's fee by an amount equal to ten percent of the net decrease; and

11.6.2.6 when both additions and credits are involved in any one change, the adjustment in CONTRACTOR's fee shall be computed on the basis of the net change in accordance with paragraphs 11.6.2.1 through 11.6.2.5 inclusive.

11.7 Whenever the cost of any Work is to be determined pursuant to paragraph 11.4 and 11.5, CONTRACTOR will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in form acceptable to ENGINEER an itemized cost breakdown together with supporting data.

Cash Allowances:

11.8 It is understood that CONTRACTOR has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be done by such Subcontractors or Suppliers and for such sums within the limit of the allowances as may be acceptable to ENGINEER. CONTRACTOR agrees that:

11.8.1 The allowances include the cost to CONTRACTOR (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the site, and all applicable taxes; and

11.8.2 CONTRACTOR's costs for unloading and handling on the site, labor, installation costs, overhead, profit

and other expenses contemplated for the allowances have been included in the Contract Price and not in the allowances. No demand for additional payment on account of any of the foregoing will be valid.

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

Unit Price Work:

11.9.1 Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the established unit prices for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by CONTRACTOR will be made by ENGINEER in accordance with paragraph 9.10.

11.9.2 Each unit price will be deemed to include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

11.9.3 CONTRACTOR or OWNER may make a claim for an adjustment in the Contract Price in accordance with Article 11 if;

11.9.3.1 the quantity of any item of Unit Price Work performed by CONTRACTOR differs materially and significantly from the estimated quantity of such item indicated in the Agreement; and

11.9.3.2 there is no corresponding adjustment with respect to any other item of Work; and

11.9.3.3 if CONTRACTOR believes that CONTRACTOR has incurred additional expense as a result thereof or OWNER believes that OWNER is entitled to a decrease in Contract Price; and

11.9.3.4 the parties are unable to agree as to the amount of any such increase or decrease.

Delays Beyond the Control of Both Parties:

11.10 Neither OWNER nor CONTRACTOR shall be entitled to an increase or decrease in the Contract Price, nor to any other compensation or damages from the other as the result of delays beyond the control of both OWNER and CONTRACTOR, such as fires, floods, epidemics, abnormal weather conditions or acts of God.

ARTICLE 12 -- CHANGE OF CONTRACT TIMES

12.1 The Contract Times (or any applicable specified milestone completion date or time) may only be changed by a Change Order or a Written Amendment. Any claim for an adjustment of the Contract Times shall be based on written notice delivered by the party making the claim to the other party and to ENGINEER promptly (but in no event later than thirty days) after the start of the occurrence of the event giving rise to the claim and stating the general nature of the claim. Notice of the extent of the claim with supporting data shall be delivered to the other party and the ENGINEER within sixty days after the start of such occurrence (unless ENGINEER allows an additional period of time to submit additional or more accurate data in support of the claim) and shall be accompanied by the claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant has reason to believe it is entitled as a result of the occurrence of said event. All claims for adjustment in the Contract Times shall be determined by ENGINEER in accordance with paragraph 9.11 if OWNER and CONTRACTOR cannot otherwise agree. No claim for an adjustment in the Contract Times will be valid if not submitted in accordance with the requirements of this paragraph 12.1.

12.2 All time limits stated in the Contract Documents are of the essence of the Agreement.

12.3 Where CONTRACTOR is prevented from completing the Work within the Contract Times (or any applicable specified milestone completion date or time), the Contract Times (or any applicable specified milestone completion date or time) will be extended in an amount equal to the time lost due to delays beyond the control of CONTRACTOR if a claim is made therefor as provided in paragraph 12.1. At OWNERs option, the Contract Times (or any applicable specified milestone completion date or time) will be extended for the entire Work or only that portion of the Work affected by the event giving rise to the claim. The CONTRACTOR will be notified in writing of the OWNERs decision in this matter. If OWNER elects to extend the Contract Times (or any applicable specified milestone completion date or time) for the affected portion of Work only, liquidated damages, if applicable, will be apportioned between affected Work and non-affected Work based on the value each portion represents as a percentage of the Contract Price. Delays beyond the control of CONTRACTOR shall include, but not be limited to, acts or neglect by OWNER, acts or neglect of utility owners or other contractors performing other work as contemplated by Article 7, fires, floods, epidemics, abnormal weather conditions or acts of God. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of CONTRACTOR.

12.4 Where CONTRACTOR is prevented from completing the Work within the Contract Times (or any applicable specified milestone completion date or time), an extension of the Contract Times (or any applicable milestone completion

date or time) in an amount equal to the time lost due to delays beyond the control of both OWNER and CONTRACTOR shall be CONTRACTOR's sole and exclusive remedy for such delays. At OWNERs option, the Contract Times (or any applicable specified milestone completion date or time) will be extended for the entire Work or only that portion of the Work affected by the event giving rise to the claim. The CONTRACTOR will be notified in writing of the OWNERs decision in this matter. If OWNER elects to extend the Contract Times (or any applicable specified milestone completion date or time) for the affected portion of Work only, liquidated damages, if applicable, will be apportioned between affected Work and non-affected Work based on the value each portion represents as a percentage of the Contract Price. In no event shall OWNER or CONTRACTOR be liable to the other for damages arising out of or resulting from (i) delays caused by or within the control of the other, or (ii) delays beyond the control of both parties including but not limited to fires, floods, epidemics, abnormal weather conditions, acts of God or acts or neglect by utility owners or other contractors performing other work as contemplated by Article 7.,

ARTICLE 13 -- TESTS AND INSPECTIONS: CORRECTION, REMOVAL OR ACCEPTANCE OF *DEFECTIVE* WORK

13.1 Notice of Defects: Prompt notice of all *defective* Work of which OWNER and ENGINEER have actual knowledge will be given to CONTRACTOR. All *defective* Work may be rejected, corrected or accepted as provided in this Article 13.

Access to Work:

13.2 ENGINEER, ENGINEER's Consultants, other representatives and personnel of OWNER, independent testing laboratories and governmental agencies with jurisdictional interests will have access to the Work at reasonable times for their observation, inspecting and testing. CONTRACTOR shall provide them proper and safe conditions for such access and advise them of CONTRACTOR's site safety procedures and progress so that they may comply therewith as applicable.

Tests and Inspections:

13.3 CONTRACTOR shall give ENGINEER timely notice of readiness of the Work for all required inspections, tests, or approvals, and shall cooperate with inspection and testing personnel to facilitate required inspections or tests.

13.4 OWNER shall employ and pay for the services of an independent testing laboratory to perform all inspections, tests, or approvals required by the Contract Documents except:

13.4.1 for inspections, tests or approvals covered by paragraph 13.5 below;

13.4.2 that costs incurred in connection with tests or inspections conducted pursuant to paragraph 13.9 below shall be paid as provided in said paragraph 13.9; and

13.4.3 as otherwise specifically provided in the Contract Documents.

13.5 If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) specifically to be inspected, tested or approved by an employee or other representative of such public body, CONTRACTOR shall assume full responsibility for arranging and obtaining such inspection, tests or approvals, pay all costs in connection therewith, and furnish ENGINEER the required certificates of inspection, or approval. CONTRACTOR shall also be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests or approvals required for OWNER's or ENGINEER's acceptance of materials or equipment to be incorporated in the Work, or of materials, mix designs, or equipment submitted for approval prior to CONTRACTOR's purchase thereof for incorporation in the Work.

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

13.7 Neither observations by ENGINEER nor inspections, tests or approvals by others shall relieve CONTRACTOR from CONTRACTOR's obligations to perform the Work in accordance with the Contract Documents.

Uncovering Work:

13.8 If any Work is covered contrary to the written request of ENGINEER, it must, if requested by ENGINEER, be uncovered for ENGINEER's observation and replaced at CONTRACTOR's expense.

13.9 If ENGINEER considers it necessary or advisable that covered Work be observed by ENGINEER or inspected or tested by others, CONTRACTOR, at ENGINEER's request, shall uncover, expose or otherwise make available for observation, inspection or testing as ENGINEER may require, that portion of the Work in question furnishing all necessary labor, material and equipment. If it is found that such Work is *defective*, CONTRACTOR shall bear all direct, indirect and consequential costs and damages of such uncovering, exposure, observation, inspection and testing and of satisfactory replacement or reconstruction, (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs), and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefor as provided in Article 11. If, however, such Work is not found to be *defective*, CONTRACTOR shall be allowed an increase in the Contract Price or an extension of the Contract Times (or any applicable specified milestone completion date), or both, directly attributable to such un-

covering, exposure, observation, inspection, testing, replacement and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, CONTRACTOR may make a claim therefor as provided in Article 11 and 12.

Owner May Stop the Work:

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

Correction or Removal of Defective Work:

13.11 If required by ENGINEER, CONTRACTOR shall promptly, as directed, either correct all *defective* Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by ENGINEER, remove it from the site and replace it with Work that is not *defective*. CONTRACTOR shall bear all direct, indirect and consequential costs and damages of such correction or removal (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs) made necessary thereby.

13.12 *Correction Period:*

13.12.1 If within one year after the date of Substantial Completion or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the Contract Documents, any Work is found to be *defective*, CONTRACTOR shall promptly, without cost to OWNER and in accordance with OWNER's written instructions, (i) correct such *defective* Work, or, if it has been rejected by OWNER, remove it from the site and replace it with Work that is not *defective*, and (ii) satisfactorily correct or remove and replace any damage to other Work resulting therefrom. If CONTRACTOR does not promptly comply with the terms of such instructions, or in an emergency where delay would cause serious risk of loss or damage, OWNER may have the *defective* Work corrected or the rejected Work removed and replaced, and all direct, indirect and consequential costs and damages of such removal and replacement (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs) will be paid by CONTRACTOR.

13.12.2 In special circumstances where a particular item of equipment is placed in continuous service for the benefit of the OWNER before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications or by Written Amendment.

13.12.3 Where *defective* Work (and damage to other Work resulting therefrom) has been corrected, removed or replaced under this paragraph 13.12, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.

Acceptance of Defective Work:

13.13 If, instead of requiring correction or removal and replacement of *defective* Work, OWNER (and, prior to ENGINEER's recommendation of final payment, also ENGINEER) prefers to accept it, OWNER may do so. CONTRACTOR shall bear all direct, indirect and consequential costs attributable to OWNER's evaluation of and determination to accept such *defective* Work (such costs to be approved by ENGINEER as to reasonableness and to include but not be limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs). If any such acceptance occurs prior to ENGINEER's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefor as provided in Article 11. If the acceptance occurs after such recommendation, an appropriate amount will be paid by CONTRACTOR to OWNER.

OWNER May Correct Defective Work:

13.14 If CONTRACTOR fails within a reasonable time after written notice from ENGINEER to correct *defective* Work or to remove and replace rejected Work as required by ENGINEER in accordance with paragraph 13.11, or if CONTRACTOR fails to perform the Work in accordance with the Contract Documents, or if CONTRACTOR fails to comply with any other provision of the Contract Documents, OWNER may, after seven days' written notice to CONTRACTOR, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph OWNER shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, OWNER may exclude CONTRACTOR from all or part of the site, take possession of all or part of the Work, and suspend CONTRACTOR's services related thereto, take possession of CONTRACTOR's tools, appliances, construction equipment and machinery at the site and incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but which are stored elsewhere. CONTRACTOR shall allow OWNER, OWNER's representatives, agents and employees, OWNER's other contractors and ENGINEER and ENGINEER's Consultant such access to the site as may be necessary to enable OWNER to exercise the rights and remedies under this paragraph. All direct, indirect and consequential costs and damages of OWNER in exercising such rights and remedies will be charged against CONTRACTOR, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and OWNER shall

be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, OWNER may make a claim therefor as provided in Article 11. Such direct, indirect and consequential costs and damages will include but not be limited to fees and charges of engineers, architects, attorneys and other professionals, court and arbitration or other dispute resolution costs and all cost of repair and replacement of Work of others destroyed or damaged by correction, removal or replacement of CONTRACTOR's *defective* Work. CONTRACTOR shall not be allowed an extension of the Contract Time because of any delay in performance of the Work attributable to the exercise by OWNER of OWNER's rights and remedies hereunder.

ARTICLE 14 -- PAYMENTS TO CONTRACTOR AND COMPLETION

Schedule of Values:

14.1 The schedule of values established as provided in paragraph 2.9 will serve as the basis for progress payments and will be incorporated into a form of Application for Payment acceptable to ENGINEER. Progress payments on account of Unit Price Work will be based on the number of units completed.

Application for Progress Payment:

14.2 At least thirty days before the date established for each progress payment, CONTRACTOR shall submit to ENGINEER for review an Application for Payment filled out and signed by CONTRACTOR covering the Work completed as of the date of the Application and accompanied by such supporting documentation as is required by the Contract Documents. If payment is required on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the site or at another location agreed to in writing, the Application for Payment shall also be accompanied by a bill of sale, invoice or other documentation warranting that OWNER has received the materials and equipment free and clear of all Liens and evidence that the materials and equipment are covered by appropriate property insurance and other arrangements to protect OWNER's interest therein, all of which will be satisfactory to OWNER. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

CONTRACTOR's Warranty of Title:

14.3 CONTRACTOR warrants and guarantees that title to all Work, materials and equipment covered by any Application for Payment, whether incorporated in the Project or not, will pass to OWNER no later than the time of payment free and clear of all Liens.

Review of Applications for Progress Payment:

14.4 ENGINEER will, within fifteen days after receipt of each Application for Payment, either indicate in writing a recommendation of payment and present the Application to OWNER, or return the Application to CONTRACTOR indicating in writing ENGINEER's reasons for refusing to recommend payment. In the latter case, CONTRACTOR may make the necessary corrections and resubmit the Application. Fifteen days after presentation of the Application for Payment to OWNER with ENGINEER's recommendation, the amount recommended will (subject to the provisions of the last sentence of paragraph 14.7) become due and when due will be paid by OWNER to CONTRACTOR.

14.5 ENGINEER's recommendation of any payment requested in an Application for Payment will constitute a representation by ENGINEER to OWNER, based on ENGINEER's on-site observations of the executed Work as an experienced and qualified engineer and on ENGINEER's review of the Application for Payment and the accompanying data and schedules that to the best of ENGINEER's knowledge, information and belief (i) the Work has progressed to the point indicated, and (ii) the quality of the Work is generally in accordance with the Contract Documents (subject to an evaluation of the Work as a functioning whole prior to or upon Substantial Completion, to the results of any subsequent tests called for in the Contract Documents, to a final determination of quantities and classifications for Unit Price Work under paragraph 9.10 and to any other qualifications stated in the recommendation), and (iii) the conditions precedent to CONTRACTOR's being entitled to such payment appear to have been fulfilled in so far as it is ENGINEER's responsibility to observe the Work. However, by recommending any such payment ENGINEER will not thereby be deemed to have represented that (i) exhaustive or continuous on-site inspections have been made to check the quality or the quantity of the Work beyond the responsibilities specifically assigned to ENGINEER in the Contract Documents or (ii) there may not be other matters or issues between the parties that might entitle CONTRACTOR to be paid additionally by OWNER or OWNER to withhold payment to CONTRACTOR.

14.6 ENGINEER's recommendation of any payment, including final payment shall not mean that ENGINEER is responsible for CONTRACTOR's means, methods, techniques, sequences or procedures of construction, or the safety precautions and programs incident thereto, or for any failure of CONTRACTOR to comply with Laws and Regulations applicable to the furnishing or performance of Work, or for any failure of CONTRACTOR to perform or furnish Work in accordance with the Contract Documents.

14.7 ENGINEER may refuse to recommend the whole or any part of any payment if, in ENGINEER's opinion, it would be incorrect to make such representations to OWNER. ENGINEER may also refuse to recommend any such payment, or, because of subsequently discovered evidence or the results of subsequent inspections or tests, nullify any such payment previously recommended, to such extent as may be necessary in ENGINEER's opinion to protect OWNER from loss because:

14.7.1 the Work is *defective*, or completed Work has been damaged requiring correction or replacement,

14.7.2 the Contract Price has been reduced by Written Amendment or Change Order,

14.7.3 OWNER has been required to correct *defective* Work or complete Work in accordance with paragraph 13.14, or

14.7.4 of ENGINEER's actual knowledge of the occurrence of any of the events enumerated in paragraphs 15.2.1 through 15.2.4 inclusive.

OWNER may refuse to make payment of the full amount recommended by ENGINEER because:

14.7.5 claims have been made against OWNER on account of CONTRACTOR's performance or furnishing of the Work,

14.7.6 Liens have been filed in connection with the Work,

14.7.7 there are other items entitling OWNER to a set-off against the amount recommended, or

14.7.8 OWNER has actual knowledge of the occurrence of any of the events enumerated in paragraphs 14.7.1 through 14.7.3 or paragraphs 15.2.1 through 15.2.4 inclusive;

but OWNER must give CONTRACTOR immediate written notice (with a copy to ENGINEER) stating the reasons for such action.

Substantial Completion:

14.8 When CONTRACTOR considers the entire Work ready for its intended use CONTRACTOR shall notify OWNER and ENGINEER in writing that the entire Work is substantially complete (except for items specifically listed by CONTRACTOR as incomplete) and request that ENGINEER issue a certificate of Substantial Completion. Within a reasonable time thereafter, OWNER, CONTRACTOR and ENGINEER shall make an inspection of the Work to determine the status of completion. If ENGINEER does not consider the Work substantially complete, ENGINEER will notify CONTRACTOR in writing giving the reasons therefor. If ENGINEER considers the Work substantially complete, ENGINEER will prepare and deliver to OWNER a tentative certificate of Substantial Completion which shall fix the date of Substantial Completion. There shall be attached to the certificate a tentative list of items to be completed or corrected before final payment. OWNER shall have seven days after receipt of the tentative certificate during which to make written objection to ENGINEER as to any provisions of the certificate or attached tentative list. If, after considering such objections, ENGINEER concludes that the Work is not substantially complete, ENGINEER will within fourteen days after submission of the tentative certificate to OWNER notify CONTRACTOR in writing, stating the reasons therefor. If, after consideration of OWNER's objections, ENGINEER considers the Work substantially complete, ENGINEER will within said fourteen days execute and deliver to OWNER and CONTRACTOR a definitive certificate of Substantial Completion (with a revised tentative list of items to be completed or corrected) reflecting such changes from the tentative certificate as ENGINEER believes justified after consideration of any objections from OWNER. At the time of delivery of the tentative certificate of Substantial Completion, ENGINEER will deliver to OWNER and CONTRACTOR a written recommendation as to division of responsibilities pending final payment between OWNER and CONTRACTOR with respect to security, operation, safety, maintenance, heat, utilities, insurance and warranties and guarantees. Unless OWNER and CONTRACTOR agree otherwise in writing and so inform ENGINEER prior to ENGINEER's issuing the definitive certificate of Substantial Completion, ENGINEER's aforesaid recommendation will be binding on OWNER and CONTRACTOR until final payment.

14.9 OWNER shall have the right to exclude CONTRACTOR from the Work after the date of Substantial Completion, but OWNER shall allow CONTRACTOR reasonable access to complete or correct items on the tentative list.

Partial Utilization:

14.10 Use by OWNER at OWNER's option of any substantially completed part of the Work, which (i) has specifically been identified in the Contract Documents, or (ii) OWNER, ENGINEER and CONTRACTOR agree constitutes a separately functioning and useable part of the Work that can be used by OWNER for its intended purpose without significant interference with CONTRACTOR 's performance of the remainder of the Work, may be accomplished prior to Substantial Completion of all the Work subject to the following:

14.10.1 OWNER at any time may request CONTRACTOR in writing to permit OWNER to use any such part of the Work which OWNER believes to be ready for its intended use and substantially complete. If CONTRACTOR agrees such part of the Work is substantially complete, CONTRACTOR will certify to OWNER and ENGINEER that said part of the Work is substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. CONTRACTOR at any time may notify OWNER and ENGINEER in writing that CONTRACTOR considers any such part of the Work ready for its intended use and substantially complete and request ENGINEER to issue a certificate of Substantial Completion for that part of the Work. Within a reasonable time after either such request, OWNER, CONTRACTOR and ENGINEER shall make an inspection of that part of the Work to determine its status of completion. If ENGINEER does not consider that part of the Work to be substantially complete, ENGINEER will notify OWNER and CONTRACTOR in writing giving the reasons therefore. If ENGINEER considers that part of the Work to be substantially complete, the provisions of paragraphs 14.8 and 14.9 will apply with respect to certification of Substantial Completion of that part of the Work and the division of responsibility in respect thereof and access thereto.

14.10.2 No occupancy or separate operation of part of the Work will be accomplished prior to compliance with the requirements of paragraph 5.15 in respect of property insurance.

Final Inspection:

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

Final Application for Payment:

14.12 After CONTRACTOR has completed all such corrections to the satisfaction of ENGINEER and delivered in accordance with the Contract Documents all maintenance and operating instructions, schedules, guarantees, Bonds, certificates or other evidence of insurance required by paragraph 5.4, certificates of inspection, marked-up record documents (as provided in paragraph 6.9) and other documents, CONTRACTOR may make application for final payment following the procedure for progress payments, except that the progress payment shall be clearly marked "Final Application for Payment." The final Application for payment shall be accompanied by (i) all documentation called for in the Contract Documents including but not limited to the evidence of insurance required by subparagraph 5.4.13, (ii) consent of the surety, if any, to final payment, and (iii) complete and legally effective releases or waivers (satisfactory to OWNER) of all Liens arising out of or filed in connection with the Work.

Final Payment and Acceptance:

14.13 If, on the basis of ENGINEER's observation of the Work during construction and final inspection, and ENGINEER's review of the final Application for Payment and accompanying documentation, all as required by the Contract Documents, ENGINEER is satisfied that the Work has been completed and CONTRACTOR's other obligations under the Contract Documents have been fulfilled, ENGINEER will, within fifteen days after receipt of the final Application for Payment, indicate in writing ENGINEER's recommendation of payment and present the Application to OWNER for payment. At the same time ENGINEER will give written notice to OWNER and CONTRACTOR that the Work is acceptable subject to the provisions of paragraph 14.15. Otherwise, ENGINEER will return the Application to CONTRACTOR, indicating in writing the reasons for refusing to recommend final payment, in which case CONTRACTOR shall make the necessary corrections and resubmit the Application. Thirty days after presentation to OWNER of the Application and accompanying documentation, in appropriate form and substance, and with ENGINEER's recommendation and notice of acceptability, the amount recommended by ENGINEER will become due and will be paid by OWNER to CONTRACTOR.

14.14 If, through no fault of CONTRACTOR, final completion of the Work is significantly delayed and if ENGINEER so confirms, OWNER shall, upon receipt of CONTRACTOR's final Application for Payment and recommendation of ENGINEER, and without terminating the Agreement, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by OWNER for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if Bonds have been furnished as required in paragraph 5.1, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by CONTRACTOR to ENGINEER with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

Waiver of Claims:

14.15 The making and acceptance of final payment will constitute:

14.15.1 a waiver of all claims by OWNER against CONTRACTOR, except claims arising from unsettled Liens, from *defective* Work appearing after final inspection pursuant to paragraph 14.11 or from failure to comply with the Contract Documents or the terms of any special guarantees specified therein; however, it will not constitute a waiver by OWNER of any rights in respect of CONTRACTOR's continuing obligations under the Contract Documents; and

14.15.2 a waiver of all claims by CONTRACTOR against OWNER other than those previously made in writing and still unsettled.

ARTICLE 15 – SUSPENSION OF WORK AND TERMINATION

OWNER May Suspend Work:

15.1 OWNER may, at any time and without cause, suspend the Work or any portion thereof for a period of not more than ninety days by notice in writing to CONTRACTOR and ENGINEER which will fix the date on which Work will be resumed. CONTRACTOR shall resume the Work on the date so fixed. CONTRACTOR shall be allowed an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any suspension if CONTRACTOR makes an approved claim therefor as provided in Articles 11 and 12.

OWNER May Terminate:

15.2 Upon the occurrence of any one or more of the following events:

15.2.1 if CONTRACTOR persistently fails to perform the Work in accordance with the Contract Documents (including, but not limited to, failure to supply sufficient skilled workers or suitable materials or equipment or failure to adhere to the progress schedule established under paragraph 2.9 as revised from time to time);

15.2.2 if CONTRACTOR disregards or violates Laws or Regulations of any public body having jurisdiction or insurance requirements;

15.2.3 if CONTRACTOR disregards the authority of ENGINEER;

15.2.4 if CONTRACTOR violates in any substantial way any provisions of the Contract Documents;

15.2.5 if CONTRACTOR has numerous or serious violations of Laws and Regulations pertaining to worker protection or safety;

15.2.6 if CONTRACTOR makes the assignment for the benefit of creditors of any of the monies due CONTRACTOR under this Agreement;

15.2.7 if CONTRACTOR intentionally submits documentation that is false or misleading;

OWNER may, after giving CONTRACTOR (and the surety, if any,) seven days' written notice and to the extent permitted by Laws and Regulations, terminate the services of CONTRACTOR, exclude CONTRACTOR from the site and take possession of the Work and of all CONTRACTOR's tools, appliances, construction equipment and machinery at the site and use the same to the full extent they could be used by CONTRACTOR (without liability to CONTRACTOR for trespass or conversion), incorporate in the Work all materials and equipment stored at the site or for which OWNER has paid CONTRACTOR but which are stored elsewhere, and finish the Work as OWNER may deem expedient. In such case CONTRACTOR shall not be entitled to receive any further payment until the Work is finished. If the unpaid balance of the Contract Price exceeds the direct, indirect and consequential costs of completing the Work (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs) such excess will be paid to CONTRACTOR. If such costs exceed such unpaid balance, CONTRACTOR shall pay the difference to OWNER. Such costs incurred by OWNER will be reviewed by ENGINEER as to their reasonableness and when so approved by ENGINEER incorporated in a Change Order, provided that when exercising any rights or remedies under this paragraph OWNER shall not be required to obtain the lowest price for the Work performed.

15.3 Where CONTRACTOR's services have been so terminated by OWNER, the termination will not affect any rights or remedies of OWNER against CONTRACTOR then existing or which may thereafter accrue. Any retention or payment of moneys due CONTRACTOR by OWNER will not release CONTRACTOR from liability.

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

15.4.1 for completed and acceptable Work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

15.4.2 for expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials or equipment as required by the Contract Documents in connection with uncompleted Work, plus fair and reasonable sums for overhead and profit on such expenses;

15.4.3 for amounts paid in settlement of terminated contracts with Subcontractors, Suppliers, and others (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration or other dispute resolution costs incurred in connection with termination of contracts with Subcontractors and Suppliers); and

15.4.4 for reasonable expenses directly attributable to termination.

CONTRACTOR shall not be paid on account of loss of anticipated profits or revenue or other economic loss or any consequential damages arising out of such termination.

CONTRACTOR May Stop Work or Terminate:

15.5 If, through no act or fault of CONTRACTOR, the Work is suspended for a period of more than ninety days by OWNER or under an order of court or other public authority, or ENGINEER fails to act on any Application for Payment within thirty days after it is submitted, or OWNER fails for thirty days to pay CONTRACTOR any sum finally determined to be due, then CONTRACTOR may, upon seven days written notice to OWNER and ENGINEER, and provided OWNER or ENGINEER do not remedy such suspension or failure within that time, terminate the Agreement and recover from OWNER payment on the same terms as provided in paragraph 15.4. In lieu of terminating the Agreement, and without prejudice to any other right or remedy, if ENGINEER has failed to act on an Application for Payment within thirty days after it is submitted, or OWNER has failed for thirty days to pay CONTRACTOR any sum finally determined to be due, CONTRACTOR may upon seven days' written notice to OWNER and ENGINEER stop the Work until payment of all amounts due CONTRACTOR, including interest thereon. The provisions of this paragraph 15.5 are not intended to preclude CONTRACTOR from making claim under Articles 11 and 12 for an increase in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to CONTRACTOR's stopping Work as permitted by this paragraph.

ARTICLE 16 -- DISPUTE RESOLUTION

Subject to the provisions of paragraph 9.10, 9.11, and 9.12, OWNER and CONTRACTOR may exercise such rights or remedies as either may otherwise have under the Contract Documents or by Laws or Regulations in respect of any dispute.

ARTICLE 17 -- MISCELLANEOUS

Giving Notice:

17.1 Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if delivered in person to the individual or to a member of the firm or to an officer of the corporation for whom it is intended, or if delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

Computation of Time:

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

17.2.2 A calendar day of twenty-four hours measured from midnight to the next midnight will constitute a day.

Notice of Claim:

17.3 Should OWNER or CONTRACTOR suffer injury or damage to person or property because of any error, omission or act of the other party or of any of the other Party's employees or agents or others for whose acts the other party is legally liable, claim will be made in writing to the other party within a reasonable time of the first observance of such injury or damage. The provisions of this paragraph 17.3 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitations or repose.

Cumulative Remedies:

17.4 The duties and obligations imposed by these General Conditions and the rights and remedies available hereunder to the parties hereto, and, in particular but without limitation, the warranties, guarantees and obligations imposed upon CONTRACTOR by paragraph 6.30, 6.31, 6.32, 13.1, 13.12, 13.14, 14.3, and 15.2 and all of the rights and remedies available to OWNER and ENGINEER thereunder, are in addition to, and are not to be construed in any way as a limitation of, any rights and remedies available to any or all of them which are otherwise imposed or available by Laws or Regulations, by special warranty or guarantee or by other provisions of the Contract Documents, and the provisions of this paragraph will be as effective as if repeated specifically in the Contract Documents in connection with each particular duty, obligation, right and remedy to which they apply.

SUPPLEMENTARY CONDITIONS

The Supplementary Conditions amend or supplement the General Conditions (***12/93 American Water System Standard General Conditions*** Edition) and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect.

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Appendix A - Sample Insurance Certificate (1 pages)
Appendix B - Release of Liens forms
(Contractor, 2 pages, Subcontractors and Suppliers, 1 page)
Appendix C - Sales Tax Guidelines (3 pages)

SUPPLEMENTARY CONDITIONS

SC-1 Definitions

The terms used in these Supplementary Conditions which are defined in the General Conditions have the meanings assigned to them in the General Conditions.

Whenever the term "Water Company" is used in these Contract Documents it shall have the same meaning as OWNER or ENGINEER, whichever is applicable.

SC-1.16 OWNER'S Consultant

The OWNER'S Consultant for this project is:

Gannett Fleming Inc.,
207 Senate Avenue
Camp Hill, PA 17011

SC-2.2 Copies of Documents

Change the number of copies from ten (10) to three (3).

SC-4.2 Subsurface and Physical Conditions

4.2.1 In the preparation of Drawings and Specifications, ENGINEER has relied upon:

4.2.1.1 The following reports of explorations and tests of subsurface conditions at the site of the Work:

_____.

4.2.1.2 The following drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Facilities) which are at or contiguous to the site of the Work:

-Drawings titled _____

4.2.1.2 The following reports of physical condition of existing structures:

_____.

Copies of these reports and drawings that are not included with the Bidding Documents may be examined at **Kentucky-American Water Company**, 2300 Richmond Road, Lexington,

KY 40502 during regular business hours. These reports and drawings are not part of the Contract Documents.

4.2.2 Anything in Paragraph GC 4.2 to the contrary not withstanding, CONTRACTOR shall not be entitled to rely on the following data:

SC-4.5.5 Chemicals Used or Stored

Chemicals known to be used or stored by the OWNER include the following:

Polyaluminum Chloride, Ferric Chloride, Corrosion Inhibitor, Caustic Soda, Hydrofluosilicic Acid, Sodium Thiosulfate, Polymer, Ammonia Hydroxide, Potassium Permanganate and Liquid Chlorine.

SC-5.3.1 QUALIFICATIONS OF INSURER

Insurance companies providing coverage shall be rated by A. M. Best with at least an "A-" rating and a financial size category of at least Class VII.

SC-5.3.2 DELIVERY OF INSURANCE CERTIFICATES

Contractors shall also provide evidence of delivery of Certificates of Insurance to additional insureds.

SC-5.4 CONTRACTOR's Liability Insurance

The limits of liability for the insurance required by Paragraph 5.*4* of the General Conditions shall provide coverage for not less than the following amounts or greater where required by Laws and Regulations:

Worker's Compensation Insurance: The CONTRACTOR shall carry ***Worker's*** Compensation Insurance during the life of the Contract to insure his statutory liability to his employees in the state or states in which the work under this Contract is to be performed, ***including $1,000,000 Employer's Liability Coverage. A Waiver of Subrogation is not required for the Worker's Compensation Policy only.***

General Liability: The CONTRACTOR shall carry Commercial General Liability Insurance during the life of the Contract. The policy shall be written on an occurrence basis and shall include broad form property damage coverage. The required limits for this coverage are to meet the limits shown in the sample Certificate of Insurance included as Appendix A of these Supplementary Conditions.

Automobile Liability: The CONTRACTOR shall carry the Comprehensive form of Automobile Liability and Property Damage Insurance during the life of the Contract. The

required limits for this coverage are to meet the limits shown in the sample Certificate of Insurance included as Appendix A to these Supplementary Conditions.

Umbrella and/or Excess Liability: The CONTRACTOR shall carry Umbrella and/or Excess Liability Insurance during the life of the Contract with limits meeting those shown in the sample Certificate of Insurance included as Appendix A to these Supplementary Conditions. ***Umbrella and/or Excess policy must follow form for both General Liability and Auto Liability policies without exception, and shall be indicated as such with an endorsement from the insurer.***

SC-5.4.7 Additional Insureds

The policies of insurance so required by Paragraph 5.4 shall include as additional insureds the following parties:

1. Kentucky-American Water Company
2. American Water Works Service Company
3. Gannett Fleming, Inc.
4. GRW Engineers, Inc.

SC-5.6 Builders Risk Insurance

The CONTRACTOR shall bear all risks of all loss or damage to the materials and Work until the Work is finally accepted by the OWNER, except that the CONTRACTOR may claim reimbursement under the OWNER's builder's risk insurance policy as herein provided and limited. OWNER will carry "All Risk" Builders Risk Insurance subject to deductibles, terms and conditions as stated in the policy and below. It is the obligation and responsibility of the CONTRACTOR to make appropriate claim to the insurance company for all losses claimed under the policy. Should any loss not be covered under this policy, in whole in or parts, the CONTRACTOR shall bear the loss. Any questions regarding coverages, limitation, exclusion, etc. contained in the policy shall be addressed by bidders prior to submittal of bids, to ***Director, Risk Management, American Water, 1025 Laurel Oak Road, Voorhees, NJ 08043.***

Such insurance shall cover the full value of the cost of replacement to the OWNER, less applicable deductibles, of all completed portions of the work to be performed throughout the entire time of construction. The deductibles on each separate and unrelated loss are: ***(1) $25,000 on loss; (2) $250,000 on loss caused by flood; (3) 5% of total insurable value for loss caused by earthquake.*** OWNER will furnish to the CONTRACTOR evidence of the insurance coverage provided.

Such insurance shall not cover (1) damage to or loss of material or equipment furnished by either party which are damaged or lost due to carelessness or negligence on the part of the CONTRACTOR, or (2) damage to or loss of machinery, tools, equipment, or other property furnished by the CONTRACTOR whether or not used by the CONTRACTOR in carrying out the terms of the Contract unless such machinery, tools, equipment or other property are specifically intended for

permanent incorporation into the Contract work and are included in an approved application for payment.

SC-6.13 Permits

OWNER will obtain and pay for all necessary permits which by Laws or Regulations must be obtained by the OWNER. The CONTRACTOR will obtain and pay for all other permits, licenses and certificates of inspection. The CONTRACTOR will pay for all inspection costs and fees.

The CONTRACTOR and/or his Subcontractor(s) shall obtain, complete, seal and sign all applications required to obtain construction permits required by state and local government agencies. A Xerox copy of the electrician's and plumber's current state and/or local license shall be delivered to the OWNER.

When required by the local governing body, the electrician and plumber will execute a mechanical bond in the form approved by the local government.

All bonds, application forms and copies of licenses shall be delivered to the OWNER so these documents may be submitted with the OWNER's application for a building permit.

SC-6.15 Sales Tax

Add the following language after Paragraph 6.15 of the General Conditions:

> Without altering CONTRACTOR's full responsibility to properly determine and pay such taxes, the OWNER will provide the CONTRACTOR, for use at CONTRACTOR's risk, a copy of any Guidelines developed by the OWNER with respect to sales and use tax exemptions in the state in which the Project is located. A copy of the Guidelines for the state in which the Project is located is included in Appendix C attached to the Supplementary Conditions.
>
> CONTRACTOR shall indemnify and hold harmless the OWNER for any sales and use tax which OWNER is required to pay by reason of CONTRACTOR's failure to seek and to implement any available Sales and Use Tax Exemption and CONTRACTOR's failure to obtain any necessary exemption certificate.
>
> OWNER may set off against monies otherwise due CONTRACTOR hereunder the amount of any sales and use tax, or any other tax, which OWNER is required to pay by reason of CONTRACTOR's failure to comply with Paragraph 6.15 of the General Conditions.
>
> CONTRACTOR shall furnish evidence satisfactory to OWNER that CONTRACTOR has paid all sales, consumer, use and other similar taxes required to be paid by CONTRACTOR. OWNER reserves the right to audit the CONTRACTOR's statement prior to release of retainage and final payment.

SC-9.3 Project Representation

The duties, responsibilities and limitations of authority of the Resident Project Representative shall be as follows:

A. General

The Resident Project Representative (RPR) is ENGINEER's agent at the site, will act as directed by and under the supervision of ENGINEER.

B. Duties and Responsibilities of RPR

1. Conferences and Meetings: Attend meetings with CONTRACTOR, such as preconstruction conferences, progress meetings, job conferences and other project-related meetings.

2. Liaison: Serve as ENGINEER's liaison with CONTRACTOR, working principally through CONTRACTOR's superintendent and assist in understanding the intent of the Contract Documents; and assist ENGINEER in serving as OWNER's liaison with CONTRACTOR when CONTRACTOR's operations affect OWNER's on-site operations.

3. Shop Drawings and Samples: Advise ENGINEER and CONTRACTOR of the commencement of any Work requiring a Shop Drawing or sample if the submittal has not been approved by ENGINEER.

4. Review of Work, Rejection of Defective Work, Inspections and Tests:

a. Conduct on-site observations of the Work in progress to assist ENGINEER in determining if the Work is in general proceeding in accordance with the Contract Documents.

b. Report to ENGINEER whenever RPR believes that any Work is unsatisfactory, faulty or defective or does not conform to the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made.

c. Verify that tests, equipment and systems startups and operating and maintenance training are conducted in the presence of appropriate personnel, and that CONTRACTOR maintains adequate records thereof.

5. Interpretation of Contract Documents: Report to ENGINEER when clarifications and interpretations of the Contract Documents are needed and transmit to CONTRACTOR clarifications and interpretations as issued by ENGINEER.

6. Modifications: Consider and evaluate CONTRACTOR's suggestions for modifications in Drawings or Specifications and report with RPR's recommendations to ENGINEER. Transmit to CONTRACTOR decisions as issued by ENGINEER.

7. Payment Requests: Review applications for payment with CONTRACTOR for compliance with the established procedure for their submission and forward with recommendations to ENGINEER, noting particularly the relationship of the payment requested to the schedule of values, Work completed and materials and equipment delivered at the site but not incorporated in the Work.

8. Completion:

a. Before ENGINEER issues a Certificate of Substantial Completion, submit to CONTRACTOR a list of observed items requiring completion or correction.

b. Conduct final inspection in the company of ENGINEER, OWNER and CONTRACTOR and prepare a final list of items to be completed or corrected.

c. Observe that all items on final list have been completed or corrected and make recommendations to ENGINEER concerning acceptance.

C. Limitations of Authority

Resident Project Representative:

1. Shall not authorize any deviation from the Contract Documents or substitution of materials or equipment, unless authorized by ENGINEER.

2. Shall not exceed limitations of ENGINEER's authority as set forth in the Agreement or the Contract Documents.

3. Shall not undertake any of the responsibilities of CONTRACTOR, subcontractors or CONTRACTOR's superintendent.

4. Shall not issue directions relative to, or assume control over, any aspect of the means, methods or techniques of construction unless such directions or control are specifically required by the Contract Documents.

SC-14.12 Final Application for Payment

Add the following language at the end of Paragraph 14.12 of the General Conditions:

CONTRACTOR, Subcontractors and Suppliers shall execute and deliver to OWNER their release of liens on forms supplied by OWNER. Blank forms are included in Appendix B of these Supplementary Conditions.

ACORD CERTIFICATE OF INSURANCE

ISSUE DATE (MM/DD/YY)

PRODUCER

Contractor Insurance Broker
[illegible] Water Street
[illegible]rleston West, WV

Phone No.
Fax No.

INSURED
Construction Contractor I $10MM, Vendor I,
AJAX Electrical Contracting
1 Main Street
Charleston, WV

THIS CERTIFICATE IS ISSUED AS A MATTER OF INFORMATION ONLY AND CONFERS NO RIGHTS UPON THE CERTIFICATE HOLDER. THIS CERTIFICATE DOES NOT AMEND, EXTEND OR ALTER THE COVERAGE AFFORDED BY THE POLICIES BELOW.

COMPANIES AFFORDING COVERAGE

COMPANY LETTER	A	XYZ Insurance Company
COMPANY LETTER	B	One Two Three Insurance Company
COMPANY LETTER	C	
COMPANY LETTER	D	
COMPANY LETTER	E	

COVERAGES

THIS IS TO CERTIFY THAT THE POLICIES OF INSURANCE LISTED BELOW HAVE BEEN ISSUED TO THE INSURED NAMED ABOVE FOR THE POLICY PERIOD INDICATED, NOTWITHSTANDING ANY REQUIREMENT, TERM OR CONDITION OF ANY CONTRACT OR OTHER DOCUMENT WITH RESPECT TO WHICH THIS CERTIFICATE MAY BE ISSUED OR MAY PERTAIN, THE INSURANCE AFFORDED BY THE POLICIES DESCRIBED HEREIN IS SUBJECT TO ALL THE TERMS, EXCLUSIONS AND CONDITIONS OF SUCH POLICIES. LIMITS SHOWN MAY HAVE BEEN REDUCED BY PAID CLAIMS.

CO LTR	TYPE OF INSURANCE	POLICY NUMBER	POLICY EFFECTIVE DATE (MM/DD/YY)	POLICY EXPIRATION DATE (MM/DD/YY)	LIMITS	
A	**GENERAL LIABILITY** ☒ COMMERCIAL GENERAL LIABILITY ☐ CLAIMS MADE ☒ OCCUR. ☐ OWNER'S & CONTRACTOR'S PROT. ☐ ☐	GLSA260T331702	01/01/2006	12/31/2006	GENERAL AGGREGATE PRODUCTS-COMP/OP AGG. PERSONAL & ADV. INJURY EACH OCCURRENCE FIRE DAMAGE (ANY ONE FIRE) MED. EXPENSE (ANY ONE PERSON)	$ 1,000,000 $ 1,000,000 $ 1,000,000 $ 1,000,000 $ 1,000,000 $ 5,000
A	**AUTOMOBILE LIABILITY** ☒ ANY AUTO ☐ ALL OWNED AUTOS ☐ SCHEDULED AUTOS ☐ HIRED AUTOS ☐ NON-OWNED AUTOS ☐ GARAGE LIABILITY	987654321	01/01/2006	12/31/2006	COMBINED SINGLE LIMIT BODILY INJURY (PER PERSON) BODILY INJURY (PER ACCIDENT) PROPERTY DAMAGE	$ 1,000,000 $ $ $
B	**EXCESS LIABILITY** ☐ UMBRELLA FORM ☒ OTHER THAN UMBRELLA FORM	L0CX045	01/01/2006	12/31/2006	EACH OCCURRENCE AGGREGATE	$ 9,000,000 $ 9,000,000
A	**WORKER'S COMPENSATION AND EMPLOYERS LIABILITY**	AEIOU	01/01/2006	12/31/2006	☒ STATUTORY LIMITS EACH ACCIDENT DISEASE-POLICY LIMIT DISEASE-EACH EMPLOYEE	 $ 1,000,000 $ 1,000,000 $ 1,000,000
	OTHER					

DESCRIPTION OF OPERATIONS/LOCATIONS/VEHICLES/SPECIAL ITEMS

Project Location:
Certificate holder is included as additional insured with respect to liability arising out of the named insured's operations performed on behalf of holder. Excess policy follows form for Employers Liability, General Liability and Auto Liability Policies without exception. Waiver of Subrogation endorsement must accompany certificate of insurance.

(Note: General Liability per occurrence limit and Auto policy per occurrence limit, combined with the Excess policies, must not be less than $10,000,000.00 Combined Total Limit of Liability.)

CERTIFICATE HOLDER

[illegible]erican Water
[illegible]00 W. Hersheypark Drive
Hershey, PA 17033

CANCELLATION

SHOULD ANY OF THE ABOVE DESCRIBED POLICIES BE CANCELLED BEFORE THE EXPIRATION DATE THEREOF, THE ISSUING COMPANY WILL XXXXXXXX TO MAIL 30 DAYS WRITTEN NOTICE TO THE CERTIFICATE HOLDER NAMED TO THE LEFT, BUT FAILURE TO MAIL SUCH NOTICE SHALL IMPOSE NO OBLIGATION OR LIABILITY OF ANY KIND UPON THE COMPANY, ITS AGENTS OR REPRESENTATIVES.

AUTHORIZED REPRESENTATIVE 28

RELEASE OF LIENS

WHEREAS, we, the undersigned, have installed or furnished labor, materials and/or equipment for the installation of the Project entitled **Kentucky River Pool 3 Water Treatment Plant**, installed pursuant to a written agreement dated _____, 20___, between the **Kentucky-American Water Company**, having an office at **2300 Richmond Road, Lexington, KY 40502**, hereinafter called OWNER and _____, having an office at _____ _____, hereinafter called CONTRACTOR, which said facilities are owned by the OWNER and described and located as follows:

Kentucky River Pool 3 Water Treatment Plant

WHEREAS, we, the undersigned, have agreed to release any and all claims and liens which we have, or might have, against the OWNER, or said facilities by reason of the labor, materials and equipment furnished by us in connection with said installation;

NOW THESE PRESENTS WITNESS that we the undersigned, in consideration of the premises, and of the sum of One Dollar ($1.00) in hand paid by the said OWNER, at and before the sealing and delivery hereof, the receipt whereof we do hereby acknowledge, have remised, released and forever quitclaimed, and by these presents do remise, release and forever quitclaim, unto the said OWNER, its successors and assigns, any and all manner of liens, claims and demands whatsoever which we now have, or might or could have, on or against the said facilities, or the owner thereof, for work done, or for equipment or materials furnished in connection with the installation thereof. It is the intent of this release that the OWNER, its successors and assigns shall and may hold, have, use and enjoy the said facilities free and discharged from all liens and demands whatsoever which we now have, or might or could have against the same if these presents had not been made.

IN WITNESS WHEREOF, we have hereunto set our hand and seal the day written opposite our signature.

Company Name _____ (SEAL)

By _____

Title _____

Dated _____, 20___

Sworn to and subscribed before me,
a Notary Public, this _____ day
of _____, 20___.

_____ (SEAL)
Notary Public

I, _____, duly authorized representative of _____
_____, designated as CONTRACTOR, do hereby state that the parties whose names are signed to the attached releases, pages 1 through ____, are all of the parties who have furnished labor, materials or equipment in connection with the construction of the facilities mentioned above; excepting only such materials as may have been furnished by the OWNER.

Dated: _____, 20__

_____
Representative's Signature

Sworn to and subscribed before me,
a Notary Public, this _____ day
of _____, 20___.

_____ (SEAL)
Notary Public

RELEASE OF LIENS

WHEREAS, we, the undersigned, have installed or furnished labor, materials or equipment for the installation of the Project entitled **Kentucky River Pool 3 Water Treatment Plant**, installed pursuant to a written agreement dated _____, 20___, between the **Kentucky-American Water Company**, having an office at **2300 Richmond Road, Lexington, KY 40502**, hereinafter called OWNER and _____, having an office at _____, hereinafter called CONTRACTOR, which said facilities are owned by the OWNER and described and located as follows:

Kentucky River Pool 3 Water Treatment Plant

WHEREAS, we, the undersigned, have agreed to release any and all claims and liens which we have, or might have, against the OWNER or said facilities by reason of the labor, materials and equipment furnished by us in connection with said installation;

NOW THESE PRESENTS WITNESS that we, the undersigned, in consideration of the premises, and of the sum of One Dollar ($1.00) in hand paid by the said OWNER, at and before the sealing and delivery hereof, the receipt whereof we, do hereby acknowledge, have remised, released and forever quitclaimed, and by these presents do remise, release and forever quitclaim, unto the said OWNER, its successors and assigns, any and all manner of liens, claims and demand whatsoever which we now have, or might or could have, on or against the said facilities, or the owner thereof, for work done, or for equipment or materials furnished in connection with the installation thereof. It is the intent of this release that the OWNER, its successors and assigns shall and may hold, have, use and enjoy the said facilities free and discharged from all liens and demands whatsoever which we now have, or might or could have against the same if these presents had not been made. And we do further certify and acknowledge, that we have received of and from the said CONTRACTOR, payment in full on account of labor done or materials or equipment furnished for or in connection with said facilities.

IN WITNESS WHEREOF, we have hereunto set our hand and seal the day written opposite our signature.

Company Name _____ (SEAL)
By _____
Title _____
Dated _____, 20 ___

Sworn to and subscribed before me, a Notary Public,
this _____ day of _____, 20___.

_____ (SEAL)
Notary Public

GUIDELINES FOR KENTUCKY CONTRACTORS

USE OF THIS GUIDELINE

This guideline may not be complete or current as of the date of the Contract or CONTRACTOR's performance of the Contract. State laws are subject to change. This guideline does not alter the CONTRACTOR's obligations under the Contract to properly determine and pay applicable taxes.

GENERAL RULE

Contractors' purchases of machinery, equipment, repair parts and supplies that will be predominantly used directly in the actual production, delivery, or rendition of the water company's utility service are not taxable.

INTERPRETATION OF GENERAL RULE

To qualify for this exemption, property must be "predominantly used" in the production, delivery, or rendition of the company's utility service and it must be "used directly" in these activities. "Predominantly used" means that more than 50% of the item's use must be involved in the direct rendition of the utility service. To determine whether an item is "used directly" in the production, delivery or rendition of the utility service, several factors are considered. Those factors are: the character of the item (i.e., whether it is in the nature of a general improvement to the premises or is particularly designed or constructed for public utility use); the causal relationship between the use of the item and the production, delivery or rendition of the utility service; the physical proximity of the items while in use; and the proximity of time of their use to the actual production, delivery or rendition of the utility service. If the item is not predominantly used directly in the production, delivery or rendition of the company's utility service, it is taxable.

SPECIFIC ITEMS

Machinery: Machinery, equipment and their foundations and parts used in actual production, rendition and delivery of a utility service are considered directly used and not taxable.

Realty Construction: Construction materials, tools and equipment predominantly used to construct, reconstruct, remodel, repair or maintain facilities which are used directly in the production, delivery or rendition of a public utility service are considered directly used and are not taxable even if the facilities constitute real estate. However, the purchase or use of property to construct reconstruct, remodel, repair or maintain a building, road or similar facility - regardless of its purpose - is taxable. The term "building" does not include machinery, equipment and parts therefore, whether or not such property is designated as real estate. Structures such as tool sheds are considered buildings;

however, certain machinery and equipment such as water and fuel tanks are not considered buildings. Tools and equipment used to maintain such facilities are exempt only if they are installed as a part of the facility. Construction materials, tools and equipment which are not predominantly used directly in the production, delivery or rendition of the utility service are taxable.

Foundations: Sand, gravel, crushed rock, concrete or similar materials used as bedding or surrounding pipe used directly in rendering the water service are not taxable. Foundations for exempt machinery and equipment are not taxable.

Maintenance Items: Tools and equipment used but not installed in the maintenance of facilities used directly in the production, delivery or rendition of a public utility service are taxable. Tools and equipment used in the maintenance of non-exempt facilities are taxable whether or not they are installed.

Pollution Control Devices: Equipment, machinery and supplies predominantly designed and used to control, abate or prevent air, water, or noise pollution generated in the rendering of the utility service are deemed to be used directly in the rendition of the utility service and, therefore, are not taxable.

Water Disposal: Property used in waste handling and disposal of pollutants is taxable unless it qualifies for the exemption for pollution controlled devices discussed above.

Space Heating, Cooling, Ventilation and Illumination: Property, including machinery and equipment, fuel or power used to ventilate buildings, lighting for general illumination, air conditioning and other space cooling, space heating and similar property, is taxable unless the property bears an active causal relationship to the production, delivery or rendition of the utility service.

Safety and Fire Prevention: Property used to prevent or fight fires, and equipment and supplies used for such programs as safety, accident prevention, or fire prevention, are taxable.

Non-Operational Activities: Property used in managerial, sales, or other non-operational activities is not used directly in the production, delivery or rendition of the public utility service and, therefore, is taxable.

Repair Parts : Repair parts which are installed and become an integral part of exempt property also are not taxable.

PROCEDURE FOR CLAIMING EXEMPTION

The contractor of utility must furnish the vendor a properly completed Sales and Use Tax Exemption Certificate (REV-1220AS+) indicating that the property being purchased qualifies for the public utility exemption.

SECTION 00800

SPECIAL CONDITIONS

1.01 UTILITY OWNERS

A. The Contractor shall not operate, move, relocate, or in any way interfere with the operation of existing utilities at, near, or outside the work area without first contacting a qualified representative of the utility involved and obtaining a written approval from this representative.

B. Per Kentucky Statutes, prior to any below grade excavation Call Before You Dig (Call BUD at 1 800 752-6007.

1.02 MAINTENANCE OF STATE AND LOCAL ROADS

A. The Contractor shall be responsible during the term of the Contract for the prompt and efficient removal, to the satisfaction of the Engineer and the owners of State and Local roads, of any soil or other debris deposited on roads or adjacent areas as a result of the Contractor's activities associated with the work to be performed under this Contract.

B. Any potholes, ruts or other damage to existing State and Local road and adjacent areas which are created by the Contractor's activities shall be immediately repaired to the satisfaction of the owner of the road, using procedures and materials approved by the owner of the road.

C. If the Contractor fails to repair or clean a road surface and adjacent areas in a timely manner or fails to repair or clean the road surface and adjacent areas to the satisfaction of the owner of the road, the owner of the road or the Owner has the right to perform the corrective work and charge the Contractor for the cost incurred. If the Contractor fails to pay the charges, said charges will be deducted by the Owner from the contract bid price.

1.03 NOTIFICATION OF OPERATION OF VALVES

A. The Contractor shall notify the Owner 10 days in advance of required operation of valves. Notification will be as specified unless otherwise noted and valves may be operated only by the Owner's personnel.

1.04 ADJACENT PROPERTY AND RIGHT-OF-WAY

A. The Contractor shall not trespass, store material or equipment or in any other manner occupy any property outside of the construction right-of-ways, easements, construction clearing and scrubbing limits, and highway right-of-way shown on the Drawings, without written permission of the Owner of the property. Any damage done by the Contractor to property outside of said work areas shall be restored immediately to the property owner's satisfaction at the Contractor's expense.

1.05 SURPLUS MATERIALS REMOVED

A. Upon completion of construction, the Contractor shall remove from the site and dispose of at his own expense all surplus material, earth, rock, unsuitable material, rubbish and refuse resulting from the work, in order that the site and adjacent premises will be left in a condition satisfactory to the Engineer. During the progress of the work, the area shall be kept clean and clear of debris and waste material.

B. It shall be the responsibility of the Contractor to locate a satisfactory landfill area for the surplus materials.

C. Surplus excavation may be disposed of on site only at areas designated or noted on the Drawings.

1.06 WORK SCHEDULE AND DAILY REPORTS

A. The Contractor shall keep the Engineer informed of his intended work schedule by regularly submitting work schedules, covering minimum periods of 1 week, at least two days before the weekly period begins. Inspection forces will be scheduled according to the Contractor's schedules. Work will not be permitted if the inspection force has not been fully informed in advance of intended work.

1.07 PROJECT RECORD DOCUMENTS

A. The Contractor's attention is directed to the requirements to provide Record Drawings as described in Division 1, Section 01700, "Project Closeout". The Contractor is advised that final payment will be withheld pending receipt of complete and accurate reproducible Record Drawings.

1.08 PRIVATE PROPERTY IMPACTS

A. Private Property: Any privately owned property such as mailboxes, signs, fences, etc., that must be removed for construction shall be replaced immediately following installation of the pipeline. The Owners of said property are to be notified of the time and duration that the property is to be removed. The Contractor shall remove, replace and store the property items at their respective Owner's request. Any property damaged shall be repaired, replaced, and restored in the same location and in equal to or better condition as before the damage occurred at the Contractor's expense.

1.09 WASTEWATER DISPOSAL PLAN

A. The Contractor shall develop a plan for safe disposal of chlorinated wastewater from disinfection/testing of pipelines, structures, etc. Submit the Plan to the Engineer for review and to Owner for review and approval at least two weeks in advance of disinfection/testing activities. Do not perform disinfection/testing prior to receipt of approval from Owner.

B. The disposal plan shall include provisions for neutralizing chlorine and any other contaminants to levels acceptable to Owner.

C. Specific methods and devices designed to prevent erosion and subsequent sedimentation at the point(s) of discharge shall also be included in the Contractor's Plan.

1.10 SITE ACCESS

A. The Contractor shall limit his access to the site, and operations on the site from State Highway 127.

1.11 SITE SECURITY

A. Consistent with the Federal Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (PL 107-188) as it may be amended from time to time, the Contractor must develop and implement a security plan including, but not limited to the following:
   1. Identification and monitoring of all contractor personnel on the project site
   2. Prohibition of unauthorized aliens on the project site
   3. Security program orientation
   4. Maintenance of a Daily Job Roster
   5. Issuance of photo identification cards
   6. Control and documentation of deliveries to the project site

B. Identification and Monitoring of Contractor (and other) Personnel
   1. Submit the following information in writing to the Owner seven (7) days after the intent to award is issued for any current employee scheduled to enter the work site:
      a. Name and job title;
      b. Address;
      c. Telephone number;
      d. Gender, date and place of birth and citizenship;
      e. Driver's License State and Number;
      f. A statement attesting to compliance with requirements of 8 USC § 1324a(b) for employment verification on each existing employee who will be working on the project at the job site(s). This information may be used for the purpose of performing background checks to confirm the validity of the above information.
   2. For any employees hired after issuance of the intent to award of contract, the above required information shall be submitted in writing at least one week prior to new employee(s) entering the project site. In-addition to contractor's direct employees, contractor shall collect, review and maintain sufficient and appropriate information, similar to or as listed above, for the employees of subcontractors, materialmen, delivery personnel, visitors or others brought on site due to contractor's operations for maintaining a secure site.

C. Prohibition of Unauthorized Aliens

1. No work on site shall be performed by an unauthorized alien, as that term is defined in 8 USC § 1324a (in subsection (h)(3)). Only persons identified as "protected individuals" as that term is defined in 8 USC § 1324a shall be allowed on the work site.

D. Maintenance of a Daily Job Roster.

1. Contractor shall establish a Daily Job Roster identifying all employees working at the site each day. All employees on the Daily Job Roster must have attended security orientation prior to entry. The Roster shall include all subcontractors, material men, delivery personnel, visitors or others who need site access due to the contractors operations.

END OF SECTION

SPECIFICATIONS

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SECTION 01000

SUMMARY OF WORK

PART 1: GENERAL

1.01 WORK UNDER THIS CONTRACT

The CONTRACTOR shall furnish all labor, materials, equipment and means to construct the project entitled **Kentucky River Pool 3 Water Treatment Plant**, as shown on the Drawings and described herein. The work includes, but is not limited to, the following:

Phase 1 Construction

Construction of pumping and treatment facilities designed with an initial treatment capacity of 20 mgd and a hydraulic capacity of 30 mgd. The work includes:

Raw water intake located at Kentucky River Pool 3; raw water pumping station; raw water transmission main, rapid mix, flocculation, clarification and filtration process systems; chemical treatment systems; post-filtration disinfection; finished water storage clearwell; high service/washwater pump station; process wastewater facilities including wastewater clarification, sludge thickening, and dewatering with belt filter presses; fully automated SCADA system; 5kv electrical service, 5kv switchboards, 480 volt switchboards and MCCs, 2000 kw standby diesel generator set, and redundant power service to the raw water pump station; and plumbing and HVAC.

Phase 2 Construction

Construction of pumping, process treatment and wastewater facilities to add 5 mgd of treatment and pumping capacity to the base, 20 mgd plant. The work includes:

1. **Add third Kentucky River intake screen, pile support system, and associated intake piping.**
2. **Add an additional 6 MGD raw water pump.**
3. **Add a parallel raw water meter in the basement of the Water Treatment Plant.**
4. **Add a new flocculator/sedimentation process basin with same capacity of the presently designed basins.**
5. **Add two more filter units of the same size as the current double cell filter boxes and expand the pipe gallery - the filter boxes and pipe gallery will be extended, but only one of the filters and face piping will be equipped.**
6. **Increase clearwell size.**
7. **Add an additional 6 MGD finished water pump.**
8. **Add a second finished water meter.**
9. **Add a second sludge thickener, add an additional thickener supernatant pump and add site piping to and from the new thickener to the solids handling control building.**
10. **Add third solids dewatering belt filter press, add a third polymer feed system, and a fourth thickened transfer sludge pump.**

11. **Add instruments and pipe a second ferric chloride bulk storage tank provided as part of Phase 1.**
12. **Instrument and program new equipment.**
13. **Architectural and Structural additions for facility additions.**
14. **Electrical additions to support new facilities and equipment.**
15. **Plumbing and HVAC additions to support new facilities and equipment.**

1.02 LOCATION

All **plant** work is to be performed on property owned by the WATER COMPANY located in **Owen County just north of the dividing line between Owen and Franklin Counties off of State Highway. The raw water pump station and intake work is to be performed on property owned by the Water Company located in Franklin County just south of the dividing line between Franklin and Owen Counties.**

1.03 WORK BY OTHERS

None.

1.04 OWNER FURNISHED PRODUCTS

A. Products furnished to the site and paid for by OWNER:

None.

1.05 CONTRACTOR USE OF SITE **(AND PREMISES)**

A. Access to site:
   1. **Plant Site – From US Route 127 approximately 500 feet north of the intersection of US Route 127 and Scantland Road and north of the county line between Franklin and Owen Counties.**
   2. **Raw Water Facilities – From McDonald Ferry Road just north of the intersection of US Route 127 and State Route 2919.**

B. Security Requirements are as follows:

   1. All Contractors employees, Subcontractors, Vendors, and agents of the Contractor shall be required to check-in with the inspector or water company personnel when entering and leaving the OWNER's premises.
   2. All Contractor's employees, Subcontractors, Vendors, and agents of the Contractor shall be required to wear and display photo identification cards provided by the Contractor while on the OWNER's premises.
   3. Drivers making deliveries for vendors for the Contractor or their Subcontractor must have identification that shows which company they are employed.
   4. The Contractor is responsible for keeping the premises secure by not making any changes or modifications that would jeopardize the security of the premises.

5. The Contractor and Subcontractor's must notify the OWNER a day in advance of any deliveries so that the water company personnel know to allow entry.

C. Construction operations: Limited to areas noted on drawings and as specified.

D. Time restrictions for performing **all** work:

No work will be permitted on Saturday, Sundays, holidays or before 7:30 a.m. or after 6:00 p.m. except as specified herein, or as approved by the OWNER or in case of emergency.

E. Utility outages and shutdown limitations are described below in Specification Section 1.07.

1.06 FUTURE WORK

Not Used.

1.08 CHANGE PROCEDURES

A. The Engineer may issue to CONTRACTOR a Proposal Request which includes a detailed description of a proposed change with supplementary or revised drawings and specifications, a change in Contract Times for executing the change and the period of time during which the requested price will be considered valid. CONTRACTOR will prepare and submit an estimate within 15 working days. The estimate shall contain a detailed breakdown of the labor, equipment, material, subcontract, equipment rental, contingencies, overhead, and profit costs associated with the requested change. The estimate shall also include any requested adjustments to Contract Times including the window of time the OWNER has to render a decision on the matter.

1.09 DEFINED TERMS

Terms used in these Specifications which are defined in the General Conditions of the Contract Documents shall have the meanings assigned to them in the General Conditions.

1.10 ABBREVIATIONS

Where any of the following abbreviations are used in the Contract Documents, they shall have the meaning set forth opposite each.

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AFBMA	Anti-Friction Bearing Manufacturers Association
AGA	American Gas Association

AGMA	American Gear Manufacturers Association
IEEE	Institute of Electrical and Electronics Engineers, Inc.
AISC	American Institute of Steel Construction
AMCA	Air Moving and Conditioning Association
ANS	American National Standard
ANSI	American National Standards Institute
API	American Petroleum Institute
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
AWPA	American Wood-Preservers' Association
AWWA	American Water Works Association
CS	Commercial Standard
IBR	Institute of Boiler and Raditor Manufacturers
IPS	Iron Pipe Size
JIC	Joint Industry Conference Standards
NBS	National Bureau of Standards
NEC	National Electrical Code; Latest Edition
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association, Inc.
Fed.Spec.	Federal Specifications issued by the Federal Supply Service of the General Services Administration, Washington, D.C.

125lb ANS	American National Standard for Cast-Iron Pipe
250lb ANS	Flanges and Flanged Fittings, Designation B16.1-1975, for the appropriate class
AWG	American or Brown and Sharpe Wire Gage
NPT	National Pipe Thread
OS&Y	Outside Screw and Yoke
Stl.WG	U.S. Steel Wire, Washburn and Moen, American Steel and Wire or Roebling Gage
UL	Underwriters' Laboratories
USS Gage	Untied States Standard Gage
WOG	Water, Oil, Gas
WSP	Working Steam Pressure

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.01 FIELD SURVEY WORK

Unless otherwise provided in the Supplementary Conditions the OWNER shall provide engineering surveys to establish reference points for construction as provided in Article 4.4 of the General Conditions. Utilizing OWNERs reference points, the CONTRACTOR shall establish the initial control base line and all control bench marks to be utilized throughout the project. Base line shall be set in accordance with all lines, dimensions, reference points, and elevations given in the Contract Drawings.

Should the CONTRACTOR detect a discrepancy between the information as presented in the Contract Drawings and any existing survey gridwork, bench marks, structures, etc., the CONTRACTOR shall notify the ENGINEER immediately. New construction shall not commence until accurate control base lines and bench marks have been established.

The CONTRACTOR shall throughout the course of the project, set all additional stakes which are needed for offset stakes, reference points, slope stakes, pavement and curb line and grade stakes, stakes for structures, sewers, utilities, roadway drainage, pipe underdrains, paved gutter, fence, culverts, or other structures, supplementary bench marks, and any other horizontal or vertical controls necessary to secure a correct layout and construction of the work. Stakes for line and grade for pavements, curbs, storm drains, sewers, etc., shall be set at twenty-five (25) foot maximum intervals. Base lines shall be staked in such manner as to clearly define them for the project.

It shall be the CONTRACTOR's responsibility that the finished work conform to the lines, grades, elevations and dimensions called for in the Contract Documents. The Work shall be subject to checking by the ENGINEER, but any inspection or checking of CONTRACTOR's layout by the ENGINEER and the acceptance of all or part of it shall not relieve the CONTRACTOR of his responsibility to secure the proper dimensions, grades, elevations and locations on the several parts of the Work. The CONTRACTOR shall exercise care in the preservation of stakes, monuments and bench marks and shall have them reset at his expense when they are lost or displaced.

Prior to the commencement of any Work activity, the CONTRACTOR shall survey and layout the Work to be performed and advise the ENGINEER of any conflicts, obstructions, concerns, etc. which will prevent completion of such work in accordance with the requirements of the Contract Documents. If the CONTRACTOR fails to conduct such survey and layout or if the survey and layout fails to identify a conflict, obstruction, etc., which it reasonably should have, and a conflict, obstruction, concern, etc., is discovered, the CONTRACTOR shall bear the cost of any standby time for labor and/or equipment which occurs pending the ENGINEER's direction and the cost of rework of any Work installed which is affected by the conflict, obstruction, etc.

Where the dimensions and locations of existing structures are of importance in the installation or connection of any part of the Work, the CONTRACTOR shall verify such dimensions and locations in the field before the fabrication of any material or equipment which is dependent on the correctness of such information.

3.02 COORDINATION AND MEETINGS

A. The CONTRACTOR will be required to coordinate his work, to phase the construction operations, and provide, install and maintain any temporary connections necessary to prevent interference to operation of OWNER's facilities. Any construction work requiring the shut-down of facilities must be scheduled and performed only at such times as shall be authorized by the ENGINEER. Such work must be completed during the specific periods authorized by the OWNER. It may be necessary that work will be performed during several shut-down periods and/or during periods of premium time payment to accomplish the desired construction. All costs to perform the CONTRACTOR's work, including premium time payments, shall be borne by the CONTRACTOR and are included in the Contract price.

B. In addition to the above, the CONTRACTOR shall:

1. Coordinate scheduling, submittals, and work of the various sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

2. Verify the utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections

having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

3. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

4. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

5. Coordinate completion and clean up of Work of separate sections in preparation for substantial completion and for portions of Work designated for OWNERs partial occupancy.

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

C. Job Progress Meetings

Progress meetings will generally be held monthly. CONTRACTOR's attendance shall be required.

1. Schedule - The OWNER will establish the meeting place, time and date, notify participants and administer the meeting. CONTRACTOR shall notify major subcontractors and suppliers, as appropriate.

2. Attendance

a. ENGINEER and/or resident project representative.
b. CONTRACTOR's project manager and project superintendent
c. OWNER's representative
d. Subcontractor, as appropriate to the agenda
e. Suppliers, as appropriate to the agenda
f. Other parties as determined by ENGINEER and/or OWNER

3. Agenda

a. Review minutes of previous meeting.
b. Review of work progress since previous meeting.
c. Review field observations, problems, conflicts.
d. Review problems which impede construction schedules.
f. Review of off-site fabrication, delivery schedules.
g. Review corrective measures and procedures to regain projected schedule.

h. Review revisions to construction schedules.
i. Review plan progress, schedule, during succeeding work period.
j. Review coordination of schedules.
k. Review submittal schedules; expedite as required.
l. Review maintenance of quality standards.
m. Review proposed changes for:
   - effect on construction schedule and on completion date
   - effect on other contracts of the project
n. Other business

4. Minutes - OWNER will prepare and distribute copies to participants and ENGINEER for review at the next meeting.

End of Section

SECTION 01010

DRAWING INDEX

PART 1: GENERAL

1.01 DRAWINGS

The following drawings, dated _____, prepared by Gannett Fleming, Inc. accompany this Specification and are part of the Contract Documents.

List of Drawings – See Contract Drawings –Index Sheet.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

End of Section

SECTION 01075

BASIS OF PAYMENT

PART 1: GENERAL

1.01 SCOPE

The lump sum Contract price constitutes full payment to the CONTRACTOR for Work to be performed under this Contract. When applicable, and authorized by OWNER, additional work will be paid for in accordance with the supplementary unit price schedule, of the Bid. The cost of labor, equipment, materials or work called for in the Specifications, shown on the Drawings, or necessary for a complete and satisfactory installation, but which are not specifically mentioned in this Section shall be included in the appropriate supplementary unit price by the CONTRACTOR at no additional expense to the OWNER.

1.02 SUPPLEMENTAL UNIT PRICE ITEMS

When applicable, and authorized by OWNER, additional work will be paid for in accordance with the supplementary unit price schedule, of the Bid. The cost of labor, equipment, materials or work called for in the Specifications, shown on the Drawings, or necessary for a complete and satisfactory installation, but which are not specifically mentioned in this Section shall be included in the appropriate supplementary unit price by the CONTRACTOR at no additional expense to the OWNER.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

End of Section

SECTION 01100

ALTERNATIVES

PART 1: GENERAL

1.01 RELATED WORK

Alternative equipment and/or materials must be listed in the Bid. Failure to submit information on alternative equipment and/or materials as requested by the ENGINEER is cause for rejection of the proposed alternative and only the specified equipment and/or materials will be permitted to be incorporated in the finished project.

All alternative equipment and/or materials offered in the Bid must comply with the detailed requirements of the Drawings and Specifications and shall be covered by the specified guarantees and warranties. If it is determined that the alternative equipment and/or materials do not conform with the Specifications, such proposed alternative shall not be accepted and the CONTRACTOR will be required to furnish and install the specified equipment and/or materials.

No alternative materials and/or equipment will be incorporated in the finished project except an alternative accepted in writing by OWNER pursuant to the requirements of this Section 1100. Acceptance by OWNER of any such alternative shall not relieve CONTRACTOR of responsibility for assuring that any such alternative will, after installation or incorporation in the Work, conform to any performance requirements and other information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.

1.02 SUBMITTALS

Specified equipment and materials have been used to prepare the Drawings. Changes in piping, wiring, structure, etc., necessary to accommodate alternatives accepted by OWNER shall be submitted by the CONTRACTOR to the ENGINEER for approval.

1.03 PAYMENT

The CONTRACTOR shall pay for all installation costs necessitated by the selection of alternative equipment and material. Such costs are included in the Contract price and any modifications as stated in the Bid.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

End of Section

SECTION 01300

SUBMITTALS

PART 1: GENERAL

1.01 BEFORE STARTING Work

A. Preliminary Progress Schedule

In accordance with Section 2.6 of the General Conditions, the CONTRACTOR shall prepare and submit to the ENGINEER for approval, a preliminary construction progress schedule. This submittal is to be made within ten (10) days from the effective date of Agreement. The method of schedule preparation required is generally referred to as the Critical Path Method (CPM).

The schedule shall include, as a minimum, the following separate activities:

1. Physical construction (includes mobilization, demobilization, setup time, lags, etc.).
2. Issuance by CONTRACTOR of purchase orders for material and equipment and submittal of shop drawings and samples to the ENGINEER.
3. Review by ENGINEER for each submittal of samples and shop drawings. Unless otherwise approved by the ENGINEER, allow a minimum of fifteen (15) working days for ENGINEER to review each submittal.
4. Fabrication time for materials and equipment.
5. Delivery of materials and equipment.
6. Installation of materials and equipment.
7. Testing, start-up and training for individual pieces of equipment or entire systems as appropriate.
8. Winter affected activities.
9. Outages or interruptions of OWNER's facilities required to perform work.
10. Demolition or removal work under this Contract.

Activity durations shall represent the best estimate of elapsed time considering the scope of the Work involved in the activity and the resources planned for accomplishing the activity expressed in working days.

Activity descriptions shall clearly define the scope of work associated with each activity. If activity descriptions contained in the schedule are not sufficient to describe the work, a supplemental narrative description is to be provided.

The construction work shall be detailed to an extent that progress can be readily monitored on a daily basis. In general, the construction work shall be detailed such that no construction activity shall have a duration greater than fifteen (15) work days.

Each activity shall be coded by the CONTRACTOR as necessary for proper and efficient utilization of the schedule. As a minimum, each activity shall be coded by:

1. Activity type (ie., submittal, ENGINEER's review, delivery, construction, etc.).

2. Responsibility (ie., CONTRACTOR, subcontractor A, subcontractor B, OWNER, ENGINEER, etc.).

3. Area (ie., Building A, Building B, sitework, etc.).

4. Work order (ie., OWNER assigned number required for monthly invoicing requirements).

The above schedule development requirements are a minimum and the CONTRACTOR shall develop the schedule as necessary to properly control and manage the project.

B. Schedule of Values

In accordance with Section 2.6 of the General Conditions the CONTRACTOR shall submit to the ENGINEER a schedule of values representing a detailed subdivision of the lump sum Contract amount. This subdivision, when approved by the ENGINEER, will become the basis for computing the contractors monthly progress payments. If practical, the schedule of values shall be developed by assigning a cost value to the appropriate activities contained in the preliminary progress schedule. If activities, or other line items, in the schedule of values contain costs associated with material, labor or subcontracts these costs are to be identified separately by listing the activity multiple times and identifying material, labor and subcontract with a suffix M, L and S respectively. Cost values for activities representing materials/equipment only shall be assigned to the activity representing delivery of such material/equipment to the job site.

In addition to the cost of material, labor and subcontracts, the following costs are to be identified separately in the schedule of values accompanied by such supporting documentation as required by the ENGINEER to substantiate the amounts listed.

1. Mobilization - To include CONTRACTOR's actual cost to setup temporary facilities at the job site.

2. Bonds, Insurance - To reflect premiums paid, or to be paid, for Bonds and insurance required to be provided per the Contract Documents. Additional insurance coverage or bonds purchased by the CONTRACTOR at his option shall be considered general overhead and apportioned to construction activity costs.

3. Job Site Overhead - To reflect the cost of maintaining the temporary facilities at the job site including the cost of direct field supervision. This value, when approved, will be paid to the CONTRACTOR in equal monthly increments based on the number of months between mobilization and final completion.

4. Demobilization - To reflect the cost of removing the temporary facilities and final site cleanup.

5. Permits - To include fees required for any permits which CONTRACTOR is required to obtain including inspection fees associated with such permits.

The cost of home office overhead, profit, financing, contingencies, etc. are to be apportioned to the construction activities in the schedule of values based on the percentage that each construction activity cost represents when compared to the subtotal of all construction activity costs. This subtotal is excluding mobilization, demobilization, job site overhead, permits, home office overhead, profit, financing, contingencies, etc. The total of all items in the schedule of values shall equal the Contract Price.

C. Preconstruction Video Taping

OWNER will perform preconstruction video taping of the site immediately prior to construction.

1.02 FINALIZING SCHEDULES

The CONTRACTOR shall be prepared to present and discuss at the preconstruction meeting, the schedules submitted in accordance with this specification. Unless additional information is required to be submitted by the CONTRACTOR, the ENGINEER will, within

15 working days of the preconstruction conference, provide comments to the CONTRACTOR. The CONTRACTOR shall then resubmit the affected schedules addressing the ENGINEER's comments.

Approval of the final schedules by the ENGINEER is advisory only and shall not relieve the CONTRACTOR of responsibility for accomplishing the work within the Contract Times. Omissions and errors in the approved CPM schedule shall not excuse performance less than that required by the Contract. Approval by the ENGINEER in no way makes the ENGINEER an insurer of the success of those schedules or liable for time or cost overruns flowing from shortcomings in such schedules.

1.03 REQUIREMENTS FOR CONFORMING WITH SCHEDULE

If, in the opinion of the ENGINEER, the CONTRACTOR falls behind the progress schedule, the CONTRACTOR shall take such steps as will be necessary to improve his progress, and ENGINEER may require CONTRACTOR to increase the number of shifts and/or overtime operations, days of work, and/or the amount of construction planned, and to submit for approval such supplementary schedule or schedules as may be deemed necessary to demonstrate the manner in which the agreed rate of progress will be regained, all without additional cost to the OWNER. An updated cash flow schedule will be required in this occurrence and will be provided with the supplementary schedules referenced above.

1.04 UPDATING SCHEDULES

The CONTRACTOR shall submit to the ENGINEER quarterly updates of the schedules required per this specification section.

Progress and shop drawing schedule updates shall reflect the progress to date by providing actual start dates for activities started, actual finish dates for completed activities, and identifying out of sequence work, schedule logic changes and any circumstances or events impacting the current schedule. The updates shall also contain the CONTRACTOR's best estimate of the remaining duration for activities not complete as of the date of the update. All graphic presentations, reports and computer discs required per the initial submittal of these schedules shall be provided with each update.

The schedule of values shall be updated to reflect any changes.

1.05 ADJUSTMENT OF PROGRESS SCHEDULE AND CONTRACT TIMES

1. If the CONTRACTOR desires to make changes in his method of operating which affect the approved progress schedule, he shall notify the ENGINEER in writing stating what changes are proposed and the reason for the change. If the ENGINEER approves these changes, the CONTRACTOR shall revise and submit for approval, without additional cost to the OWNER, all of the affected portions of the schedule.

2. Shop drawings and samples which are not approved on the first submittal or within the schedule time shall be immediately rescheduled, as well as any work which fails to pass specified tests or has been rejected.

3. The Contract Times will be adjusted only for causes specified in the General Conditions. In the event the CONTRACTOR requests an adjustment of the Contract times, he shall furnish such justification and supporting evidence as the ENGINEER may deem necessary for a determination as to whether the CONTRACTOR is entitled to an adjustment of Contract Times under the provisions of the General Conditions. The ENGINEER will, after receipt of such justification and supporting evidence, make findings of fact and will advise the CONTRACTOR in writing thereof. If the ENGINEER finds that the CONTRACTOR is entitled to any adjustment of the Contract Times the ENGINEER's determination as to the total number of days adjustment shall be based upon the currently approved progress schedule and on all data relevant to the adjustment. The CONTRACTOR acknowledges and agrees that actual delays in activities which, according to the progress schedule, do not affect the Contract completion date shown by the critical path in the network will not be the basis for an adjustment of Contract Times.

4. From time to time it may be necessary for the progress schedule and/or Contract Times to be adjusted by the OWNER to reflect the effects of job conditions, weather, technical difficulties, strikes, unavoidable delays on the part of the OWNER, and other unforeseeable conditions which may indicate schedule and/or Contract Times adjustments. Under such conditions, the ENGINEER shall direct the CONTRACTOR to reschedule the work and/or Contract Time to reflect the changed conditions, and the CONTRACTOR shall revise his schedule accordingly. No additional compensation shall be made to the CONTRACTOR for such changes except as provided in the General Conditions. Unless otherwise directed, the CONTRACTOR shall take all possible actions to minimize any extension to the Contract Times and any additional cost to the OWNER.

1.06 SHOP DRAWINGS

The CONTRACTOR shall promptly supply to the ENGINEER for approval, shop drawings with details and schedules for all items contained in the list of required Shop Drawings included at the end of this Section, or for other items as may be required by the ENGINEER.

A sufficient number of copies to allow the OWNER to retain four (4) reviewed copies of all drawings, schedules and brochures shall be submitted for approval. Black line prints, blue line prints or reproducible transparencies are required. Blueprints (white lines on a blue background) are not acceptable. Each submittal shall have the job name on it and the appropriate specification section or contract drawing reference.

Shop drawings shall be numbered with the WATER COMPANY's file number ___-___-XX Rev. _____. Detailed procedures for numbering will be outlined at the pre-construction meeting.

Each copy of the submittals made to the WATER COMPANY for approval shall be prepared by the CONTRACTOR and shall have an identifying title stamp as follows:

Kentucky-American Water Company
Lexington Service Area
Kentucky River Pool 3 Water Treatment Plant
Specification Section _____
Shop Drawing No. ___-___-___ Rev. _____

As required by the General Conditions, each copy of the submittals shall also be stamped with the CONTRACTOR's approval indicating that the shop drawing has been reviewed for conformance to the Contract Documents and has been coordinated with all other work and/or trades. The CONTRACTOR shall identify and bring to the attention of the ENGINEER any deviations to the Contract Documents contained in the submittal. For shop drawings being resubmitted the CONTRACTOR shall identify and bring to the attention of the ENGINEER any revisions other than those originally requested by the ENGINEER.

Submittals smaller than 8½x11 inches shall be secured to paper 8½x11 inches. Submittals will be returned, stamped with the following classifications:

a) "Approved" - There are no notations or comments on the submittal and, in our opinion, the submittal meets the requirements of the Contract Documents and the CONTRACTOR may release the equipment for production.

b) "Approved as Noted" - Notations have been made on the submittals to insure conformance with the Contract Documents. The CONTRACTOR may release the equipment for production in accordance with the notations.

c) "Not Approved" - The submittal does not meet the requirements of the Contract Documents. The CONTRACTOR must submit the specified product.

d) "Revise and Resubmit" - When the material submitted is incorrect or insufficient to review properly and it is necessary to see the complete package again.

e) "Resubmit Record Copy" - Used with the review action "Approved As Noted". The resubmittal shall incorporate notations.

Where a submittal indicates a departure from the Contract which the ENGINEER deems to be a minor adjustment in the interest of the OWNER not involving a change in Contract Price or extension of Contract Times, the ENGINEER may approve the submittal but the approval will contain, in substance, the following notation:

"The modification indicated on the attached submittal is approved in the interest of the OWNER to effect an improvement for the Project and is accepted with the understanding that it does not involve any change in the Contract Price or Times; that it is subject generally to all Contract stipulations and covenants; and that it is without prejudice to any and all rights of the OWNER under the Contract Bonds."

It is emphasized that the ENGINEER's approval of CONTRACTOR's submitted data is for general conformance to the Contract Drawings and Specifications, but subject to the detailed requirements of Drawings and Specifications. Although the ENGINEER may check submitted data in more or less detail, such checking is an effort to discover errors and omissions in CONTRACTOR's drawings and to assist the CONTRACTOR in coordinating and expediting his work, and shall in no way relieve the CONTRACTOR of his responsibility to engineer the details of the Work in such manner that the purpose and intent of the Contract will be achieved, nor shall such detail check by the ENGINEER be construed as placing on the ENGINEER, any responsibility for the accuracy, and for proper fit, functioning and performance of any phase of the Work included under this Contract.

1.07 SAMPLES

When required by the ENGINEER or where noted in other Sections of these Specifications, samples or materials shall be submitted for approval.

Submit samples to illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

Submit samples of finishes from the full range of manufacturer's standard colors, textures, and patterns for ENGINEER's selection.

Include identification on each sample, with full project information.

Submit the number or samples specified in individual specification sections; one of which will be retained by ENGINEER.

Reviewed samples which may be used in the Work are indicated in individual specification sections.

1.08 PROGRESS PAYMENTS

The detailed arrangement for submittal of progress payments shall be discussed at the preconstruction meeting. In general, progress payments shall be submitted monthly in a format acceptable to the ENGINEER. The progress payment request shall be based on the approved schedule of values and should provide the percentage of completion, total dollar value completed, dollar value completed prior to the current payment, and the amount requested for this progress payment for each line item contained in the schedule of values. Progress payment requests for material and/or equipment suitably stored but not yet incorporated into the work shall be accompanied by a copy of the appropriate manufacturers invoice, shipping order, bill of lading, etc. and the progress payment amount shall be the direct cost to the CONTRACTOR, or subcontractor, for such material and/or equipment. Payment will not be made to the CONTRACTOR if, upon inspection by the ENGINEER, it is determined that the material and/or equipment does not conform to the requirements of the Contract Documents including proper storage, receipt of approved shop drawings, receipt of any special guarantees, Bonds, insurance coverage, any evidence of damage or imperfections, etc.

1.09 CONTRACTOR'S DAILY REPORTS

If requested by the ENGINEER or the Resident Project Representative, the CONTRACTOR shall prepare and submit daily reports containing the following information:

- The number of craftsmen and hours worked of each subcontractor,
- the number of hours worked by each trade,
- the number of hours worked of each type of equipment,
- a description of work activities performed,
- a description of any material or equipment deliveries,
- description of obstructions encountered,
- temperature and weather conditions.

The daily reports shall be submitted on a daily basis, by the end of the next business day.

Information provided on the daily report shall not constitute notice of delay or any other notice required by the Contract Documents. Notice shall be as required therein.

1.10 OPERATING AND MAINTENANCE INSTRUCTION MANUALS

Prepare complete written maintenance and operating instructions covering the equipment provided under this Contract. Divide the operating instructions into basic sections according to type of equipment.

Instructions shall describe all equipment and controls, their purpose, and their operation and use. Include maintenance checklists for use by the OWNER's personnel and a

complete listing of replacement parts with pertinent information relative to ordering such parts.

Submit instructions in duplicate draft form for review by the ENGINEER at least eight weeks prior to initial operation, and in final form within thirty days after return of one copy of the draft with the ENGINEER's notations.

Prior to release of Final Payments, revise and resubmit copies of the instructions to accord with any changes in procedures or equipment made during start-up or initial operation. Resubmittals are also required for changes made during the guarantee period.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

End of Section

SECTION 01500

TEMPORARY FACILITIES

PART 1: GENERAL

1.01 WATER SUPPLY

If reasonably available, water for the purpose of this Contract will be supplied to the CONTRACTOR by the OWNER. The CONTRACTOR shall furnish and install all necessary meters, temporary piping and valves in connection with such water supply.

The OWNER reserves the right to impose limitations upon the CONTRACTOR'S use of water as the OWNER, in its sole discretion, determines may be necessary to assure it of its continued ability to meet the demands of its customers and the volumes and pressures required for fire protection. Any water required by the CONTRACTOR in excess of the quantities the OWNER provides to the CONTRACTOR must be furnished by the CONTRACTOR at his own cost.

1.02 TEMPORARY HEAT

The CONTRACTOR shall provide approved type heating apparatus with the necessary fuel in order to protect and/or dry out the work. The stored materials and finished work shall be protected at all times from damage by the weather elements.

1.03 ELECTRICAL SUPPLY

The CONTRACTOR shall pay all fees, obtain necessary permits and have meter installed for power and light as may be required for the prosecution of his work. The OWNER can provide 115V power for CONTRACTOR'S use during the project.

1.04 TEMPORARY LIGHTING

Provide and maintain incandescent lighting for construction operations and lighting to exterior staging and storage areas after dark for security purposes.

1.05 BARRIERS

Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing buildings. Provide protection for plant life designated to remain. Replace damaged plant life.

1.06 FENCING

Not required.

1.07 PARKING

If space is not available on the existing paved areas, arrange for temporary gravel parking areas to accommodate construction personnel.

1.08 PROGRESS CLEANING

Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust. Remove waste materials, debris, and rubbish from site weekly and dispose off-site.

1.09 SANITARY FACILITIES

The CONTRACTOR shall provide suitable temporary facilities and enclosures for the use of workmen and shall maintain same in a sanitary condition.

The CONTRACTOR is advised that the OWNER is in the business of providing potable water and the CONTRACTOR'S sanitary arrangements shall not endanger the OWNER'S facilities.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

End of Section

SECTION 01600

PRODUCTS

PART 1: GENERAL

1.01 PROTECTION OF MATERIAL AND EQUIPMENT

All electrical and mechanical equipment shall be stored in a warm, dry shelter with proper ventilation. Under no circumstances shall motors, electrical control equipment or any other electrical or mechanical equipment be stored under polyethylene plastic covers or tarpaulins. When space is available inside existing structures, and the OWNER approves, the CONTRACTOR will be allowed to store equipment inside them. Should such space not be available, the CONTRACTOR shall construct a shelter with a source of heat and proper ventilation as approved by the ENGINEER for the storage of equipment.

The interior of all pipe and accessories shall be kept free from dirt and foreign matter at all times.

After valves and hydrants have been inspected, the CONTRACTOR shall properly store them prior to use. In order to prevent entry of foreign material that could cause damage to the seating surfaces, the valves and hydrants shall be stored in a fully closed position unless recommended otherwise by the manufacturer. Resilient seated valves shall be stored in accordance with the manufacturer's recommendations. This may include storage with protective covers for rubber seats and in marginally open condition. Valves and hydrants should be stored indoors.

If valves must be stored outdoors, the CONTRACTOR shall protect the operating mechanism, such as gears, motor, actuators and cylinders, from weather elements. Valve ports and flanges must be protected from the weather and foreign materials. If valves are subject to freezing temperatures, all water must be removed from the valve interior and the valve closed tightly before storage, unless specifically recommended otherwise by the manufacturer. Valves shall be stored on pallets with the discs in a vertical position to prevent rainwater from accumulating on top of the disc, seeping into the valve body cavity and freezing and cracking the casting.

1.02 SERVICING EQUIPMENT

The CONTRACTOR shall check all equipment upon acceptance to determine if oil reservoirs are full and areas to be greased are properly packed with grease. The CONTRACTOR will provide the proper grease or oil for use in lubricating the required areas in the equipment. Any service to equipment while in storage, or installed pending acceptance, is the responsibility of the CONTRACTOR and shall be performed per manufacturer's requirements, industry standards or as stated specifically in the technical specifications.

1.03 MATERIAL/EQUIPMENT FURNISHED BY OWNER

Certain material and equipment will be furnished by the OWNER as noted in the Contract Documents. The CONTRACTOR's responsibility for material and/or equipment furnished by the OWNER shall begin upon the CONTRACTOR's acceptance of such material and/or equipment at the point of delivery to him. All material and equipment shall be examined and items found to be defective in manufacture and/or otherwise damaged shall be rejected by the CONTRACTOR at the time and place of delivery to him. The OWNER will thereupon repair or replace the damaged items.

After acceptance of material and/or equipment by CONTRACTOR at point of delivery to him, CONTRACTOR shall be responsible for the proper storage, handling, servicing and installation of such material and/or equipment in accordance with manufacturer's recommendations, industry standards or specific requirements of the Contract Documents. Any material and/or equipment found to be defective prior to acceptance by the ENGINEER shall be repaired or replaced by CONTRACTOR at no additional cost to OWNER unless CONTRACTOR submits proof that such defect was latent and could not have been detected by CONTRACTOR when performing his duties and responsibilities under these Contract Documents.

CONTRACTOR's vs. OWNER's responsibilities for providing guarantees or warranty and manufacturer's representatives for service, inspection, certification of installation, installation, field training, start-up, etc. for material and/or equipment furnished by OWNER shall be as follows unless otherwise specified: OWNER will provide the warranty and CONTRACTOR is responsible for providing manufacturer's representatives for all necessary field service, start-up service, installation certifications, installation, field training of OWNER's personnel, etc. for OWNER furnished material and/or equipment as required for acceptance of such material and/or equipment in the completed project.

PART 2: PRODUCTS

2.01 GENERAL

Unless otherwise specifically provided for in these Specifications, all equipment, materials and articles incorporated in the work shall be new, in current production and the best grade obtainable consistent with general construction usage.

2.02 COORDINATION OF DIMENSIONS

The CONTRACTOR shall verify and make necessary corrections to construction dimensions so that all specified and/or alternative equipment, which is approved by the ENGINEER, can be installed and will function within the intent of the Contract Drawings and Specifications. The CONTRACTOR will promptly notify the ENGINEER of all necessary corrections required.

2.03 SAFETY AND HEALTH REQUIREMENTS

All materials, equipment, fixtures and devices furnished shall comply with applicable Laws and Regulations.

All equipment furnished and installed under this Contract shall be equipped with suitable and approved safety guards and devices required for the safety of the public and operating personnel. Such guards and safety devices shall be in accord with the latest requirements of safety codes approved by the American National Standards Institute as well as the safety requirements of applicable Laws and Regulations. Where said safety codes of the ANSI are incompatible with applicable Laws and Regulations, said Laws and Regulations shall prevail.

PART 3: EXECUTION

3.01 INSTALLATION

Material and equipment shall be installed in accordance with the appropriate Sections of these Specifications.

3.02 SERVICES OF MANUFACTURER'S REPRESENTATIVE

The CONTRACTOR shall arrange for a qualified service representative from each company, manufacturing or supplying certain equipment as required by the individual Specification Sections to perform the duties herein described.

After installation of the applicable equipment has been completed and the equipment is presumably ready for operation, but before it is operated by others, the representative shall inspect, operate, test, and adjust the equipment. The inspection shall include but shall not be limited to, the following points as applicable:

a. soundness (without cracked or otherwise damaged parts)
b. completeness in all details, as specified
c. correctness of setting, alignment, and relative arrangement of various parts
d. adequacy and correctness of packing, sealing and lubricants

The operation, testing, and adjustment shall be as required to prove that the equipment is left in proper condition for satisfactory operation under the conditions specified.

On completion of his Work, the manufacturer's or supplier's representative shall submit to the ENGINEER a complete signed report of the result of his inspection, operation, adjustments, and tests. The report shall include detailed descriptions of the points inspected, tests and adjustments made, quantitative results obtained if such are specified, and suggestions for precautions to be taken to ensure proper maintenance. The report also shall include a certificate that the equipment conforms to the requirements of the Contract

Documents and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

After the ENGINEER has reviewed the reports from the manufacturers' representatives, the CONTRACTOR shall make arrangements to have the manufacturers' representatives present when the mechanical performance tests are made.

End of Section

SECTION 01650
TESTING

PART 1: GENERAL

1.01 DESCRIPTION

This Section covers testing in accordance with the Specifications, as shown on the Drawings, and as necessary for a complete and satisfactory installation.

1.02 PIPELINES

All pipelines, valves, appurtenances, etc. installed per these Contract Documents shall be tested in the manner described by the technical specifications. Unless otherwise stated, all pipelines shall be hydrostatically tested, with no leakage, at a pressure at least equal to the maximum operating pressure of the pipeline.

1.03 WATER CONTAINING VESSELS

Prior to backfilling around water containing vessels, the CONTRACTOR shall fill said vessels with water for a period of at least 7 days in order to insure vessels are watertight. If any vessel leaks, it shall be repaired to the satisfaction of the ENGINEER and retested until no leakage occurs.

1.04 LIQUID CHEMICAL STORAGE TANKS

Prior to filling bulk storage tanks, batch and day tanks with appropriate chemicals, each tank shall be filled with water for a period of at least 7 days in order to insure each tank is watertight. If any tank leaks, it shall be replaced or repaired by a factory trained representative to the satisfaction of the ENGINEER, and retested until no leakage occurs.

1.05 DAMPPROOFING AND PAINTING

During the application of dampproofing and painting, the CONTRACTOR shall have the manufacturer's representative check the dry mil thickness of each coating and certify to the ENGINEER in writing that the thickness is in compliance with the Specifications. If deficiencies in the dry mil thickness of any coat are found, they shall be corrected by the application of an additional coat(s) to the said deficient area. The certificate shall also state that all surfaces were properly cleaned prior to the application of dampproofing and paint, specified meetings and inspections were made, the quantity of dampproofing and paint were applied in accordance with their recommendations, and all other requirements stated in the Specifications have been satisfactorily completed.

1.06 MECHANICAL PERFORMANCE TESTS

A. General

1. As a prerequisite to the ENGINEER's issuance of the Certificate of Substantial Completion, the CONTRACTOR shall conduct initial and final performance tests as described hereafter. The CONTRACTOR shall perform all tests with his own forces and such equipment representatives and other experts (hereinafter collectively referred to as "CONTRACTOR's personnel") as may be required by the Specifications or necessary for a successful test. All operations and coordination of the tests from their beginning to their satisfactory completion as determined by the OWNER and ENGINEER shall be the complete responsibility of the CONTRACTOR.

2. The general sequencing of the testing shall be developed by the CONTRACTOR. In general the sequence should focus on the testing of individual pieces of equipment prior to testing entire systems including automatic control systems.

3. At least 14 days prior to the proposed testing, the CONTRACTOR shall submit in writing to the ENGINEER a complete outline of his proposed procedure for testing. No testing shall begin until approval is given. Such approval shall be for the general schedules of testing and in no way relieves the CONTRACTOR of his responsibility for conducting the test expeditiously and with an adequate number of personnel to handle all emergencies.

4. The CONTRACTOR shall also be responsible for maintenance during the testing period and for repair of any damage resulting from the testing procedure. If the CONTRACTOR does not have sufficient personnel to handle an emergency and the OWNER must make repairs of damage, caused by the CONTRACTOR's actions, with his own forces, the CONTRACTOR shall reimburse the OWNER for this work.

5. Wages and salaries of CONTRACTOR's personnel as may be required by any and all tests specified herein shall be paid for by the CONTRACTOR and included in the lump sum price bid.

B. Initial Mechanical Performance Tests

1. The CONTRACTOR shall give the OWNER at least 14 days written notice prior to the commencement of mechanical performance tests.

2. The CONTRACTOR's personnel demonstrate to the ENGINEER, in the presence of OWNER's personnel, that the manual and automatic controls,

performance over full operative range, efficiency, safety items, alarms, etc., of each mechanical and electrical item of equipment will operate in accordance with the design intent as indicated by the Drawings and/or described in the Specifications. At this time, the CONTRACTOR's personnel shall also instruct and train the OWNER's personnel in the operation of all equipment, controls, safety devices, etc.

C. Final Mechanical Performance Tests

1. Final Mechanical Performance Tests shall cover a continuous 1-week period while the facility is in continuous normal operation. During the Final Mechanical Performance Tests, the CONTRACTOR shall demonstrate, to the satisfaction of the ENGINEER, with OWNER's personnel present, that all equipment is coordinated and operating properly; that all controls, safety features, and alarms operate satisfactorily in coordination with the equipment installed; and that installed equipment complies in all respects mechanically and electrically with applicable Drawings and Specifications. The CONTRACTOR is responsible for mechanical operation of the facilities. The OWNER will be present during the entire test period to provide direction to the CONTRACTOR's personnel in regards to water treatment requirements and plant production rates. Upon completion of the test period, the CONTRACTOR shall be provided with a written list of any operating problems, equipment malfunctions, or other deficiencies related to plant operations. The CONTRACTOR must correct these deficient items and retest the affected system. The retesting shall be performed for a time period sufficient to demonstrate the proper operation of the system. This time period will not exceed 1-week.
   a. Final mechanical performance tests for each pump to be conducted as soon as individual pump installation is complete. Additional pumps cannot be removed from service until each newly installed pump has been successfully tested, unless authorized by the OWNER.

2. After the CONTRACTOR receives from the ENGINEER written acceptance of the Final Mechanical Performance Tests, the CONTRACTOR's responsibilities relative to operation of the facility shall be terminated, and the OWNER will assume the responsibility. The CONTRACTOR shall, however, remain responsible for any further training or extended run-in or adjustment periods for specific pieces of equipment or systems as required by the Specifications.

D. Include costs for the above tests in unit and lump sum price bid for the Project.

PART 2: PRODUCTS

Not applicable to this section.

PART 3: EXECUTION

Not applicable to this section.

End of Section

SECTION 01656

DISINFECTION OF WATER MAINS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for disinfection of water mains, including chemical feed lines.

B. Related Sections:
   1. Special Conditions: Section 00800.

1.02 REFERENCES

A. American National Standards Institute:
   1. ANSI/NSF Standard 60, Listing of Certified Drinking Water Treatment Chemicals – Health Effects.

B. American Water Works Association:
   1. AWWA B300, Standard for Hypochlorites.
   2. AWWA B301, Standard for Liquid Chlorine.
   3. AWWA C651, Standard for Disinfecting Water Mains.

1.03 SUBMITTALS

A. Bacteriological Test Results: See Bacteriological Tests below.

B. Wastewater Disposal Plan: Submit in accordance with Section 00800 - Special Conditions.

1.04 QUALITY ASSURANCE

A. Bacteriological Tests:
   1. See AWWA C651, Sections 7 and 8.
      a. Required Number of Samples:
         1) Plant Water Service: One sample.
         2) Treated Water: One sample each line.
         3) Backwash Water: One sample.
         4) Raw Water: One sample.
         5) Clearwell Effluent: One sample.
         6) Filter Effluent: One each line.
         7) Plant Effluent: One sample.
         8) Mixed Water: One sample.
         9) Recycled Water: One sample.
         10) Filter Drain: One sample each line.
         11) Water Main: Two samples per section of main tested.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle, and store specified disinfection products in manner recommended by respective manufacturers to prevent contamination and deterioration of products.

B. When handling disinfection products, due caution is advisable. Wear gloves, apron, goggles, and suitable vapor mask.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Do not test or disinfect water mains if air temperature is expected to fall below 35 degrees F.
   2. Keep pipe interior clean. Close open end of pipe with water tight plug when pipe laying is not in progress.

B. Operational Requirements:
   1. Notify Owner a minimum of 24 hours in advance of any flushing operation.
   2. Owner's representative must be present for operating valves required to fill mains. Valves may only be operated by Owner's personnel.
   3. Flushing will be monitored by the Owner.

PART 2 PRODUCTS

2.01 MATERIALS

A. Hypochlorites: Standard AWWA B300.

B. Liquid Chlorine: Standard AWWA B301.

C. Provide NSF Standard 60 certified products per Listing of Certified Drinking Water Treatment Chemicals – Health Effects.

PART 3 EXECUTION

3.01 WATER MAIN DISINFECTION

A. Disinfect water main installed under this Contract before placing in service.

B. Form of Chlorine for Disinfection: With Engineer's approval, follow either of these two designated methods of procedure.
   1. Liquid Chlorine: Apply chlorine gas-water mixture with solution feed chlorinating device in combination with booster pump for injecting chlorine gas-water mixture into main to be disinfected. Use only if Contractor can demonstrate to Engineer that person supervising operation is thoroughly familiar and experienced in handling chlorine gas, suitable equipment is used, and proper safety equipment is available.

2. Calcium Hypochlorite Solution: Prepare chlorine-water solution of 1 percent available chlorine using granular calcium hypochlorite. Inject or pump solution into pipeline. Prepare chlorine-water solution of 1 percent available chlorine by mixing approximately 1 pound of calcium hypochlorite with 8 gallons of water.

C. Preparation:
   1. Preliminary Flushing: Prior to disinfection, thoroughly flush section of water main being disinfected with available water pressure and outlets.
   2. Flush after pressure and leakage tests are complete.
   3. Refer to Section 00800 - Special Conditions for requirements for a Wastewater Disposal Plan.

D. Chlorination:
   1. Chlorine Application: Apply hypochlorite solution to water main with gasoline or electrically-powered chemical feed pump. For smaller applications, prepare solution in a barrel and pump into main with hand pump, such as a hydraulic test pump. Apply at dosage rate resulting in chlorine concentration in water in pipe is a minimum of 25 mg/l free chlorine. Table below gives amount of calcium hypochlorite and quantity of 1 percent hypochlorite solution required to produce 25 mg/l chlorine concentrate in 100 feet of pipe:

CALCIUM HYPOCHLORITE AND CHLORINE SOLUTION REQUIRED TO PRODUCE 25 MG/L CONCENTRATION IN 100-FEET OF PIPE

Pipe Size Inches	Contents in 100-ft.		Section Gals.	Quantity of Calcium Hypochlorite		1% Chlorine Solution Gallons
	Cu.Ft.	Lbs.		Ounces	Pounds	
3	4.90	306	37	1/5	0.012	0.09
4	8.73	545	66	1/3	0.021	0.16
6	19.65	1,227	147	3/4	0.046	0.36
8	34.90	2,178	261	1-3/8	0.083	0.65
10	54.28	3,388	406	2-1/8	0.131	1.02
12	78.48	4,899	587	3-0	0.185	1.44
16	139.98	8,738	1,047	5-3/8	0.334	2.60
20	218.06	13,611	1,631	7-3/4	0.486	4.08
24	314.16	19,603	2,350	11-5/32	0.698	5.88
30	490.87	30,630	3,672	16-3/32	1.090	9.19
36	706.86	44,108	5,287	25-1/8	1.570	13.23

CALCIUM HYPOCHLORITE AND CHLORINE SOLUTION REQUIRED TO PRODUCE 25 MG/L CONCENTRATION IN 100-FEET OF PIPE						
Pipe Size Inches	Contents in 100-ft.		Section Gals.	Quantity of Calcium Hypochlorite		1% Chlorine Solution Gallons
42	962.11	60,036	7,197	34-5/16	2.144	17.99
48	1,256.64	78,414	9,400	44-13/16	2.801	23.50
54	1,590.43	99,243	11,896	56-23/32	3.544	29.74
66	2,375.83	148,252	17,771	84-23/32	5.295	44.43

Feet of Pipe in Which 1 Ounce of Calcium Hypochlorite Will Produce 25 mg/l Available Chlorine														
3"	4"	6"	8"	10"	12"	16"	20"	24"	30"	36"	42"	48"	54"	66"
576	324	144	79	51	36	20	13	9	6	4	3	2	1.8	1.2

2. Point of Application: Apply chlorinating agent at high end of pipeline section being chlorinated and through a corporation stop inserted in top of new pipe. If water for preparation of chlorine solution is supplied from tap on existing pipeline, provide a physical break between injector supply and injector or pump.
3. Rate of Application: Pump chlorine solution slowly into new pipeline. Do not cease chlorine application until entire main is filled with chlorine solution. If required by Engineer, measure chlorine residual at several points along section of main being disinfected to ensure that proper dosage and distribution of chlorine solution is obtained.
4. Prevention of Reverse Flow: Exercise great care in manipulating valves, so strong chlorine solution in line being treated will not flow back into adjoining water distribution system.
5. Retention Period and Chlorine Concentration: Retain chlorinated water in main for at least 24 hours. Operate all valves and hydrants in section in order to disinfect appurtenances. At end of this 24 hour period, maintain 10 mg/l chlorine residual throughout length of main.
6. Final Flushing: Following chlorination, thoroughly flush heavily chlorinated water from main at its extremities until replacement water throughout its length, is tested comparable to quality of water in existing distribution system.
7. Flushing Water: Owner will provide water for flushing, however, do not operate valves on water distribution system without presence of duly qualified representative of Owner.
8. Refer to Section 00800 - Special Conditions for requirements related to preparation and approval of a Wastewater Disposal Plan.

E. Bacteriological Tests: After final flushing and before each treated water main is placed in service, collect samples from end of line. Test samples for bacteriological quality in accordance with Standard Methods to show absence of coliform organisms. Take samples of water that has been standing in main for at least 16 hours after final flushing has been completed.

F. Redisinfection: If initial disinfection fails to produce satisfactory bacteriological samples, reflush and resample main. If check samples show presence of coliform organisms, rechlorinate main as specified previously.

G. Water required for one disinfection and one flushing of main will be furnished by Owner at no cost to Contractor. If main requires additional disinfecting or flushing, Contractor is responsible for associated costs.

H. Include costs for disinfection of water main in unit or lump sum prices bid for Work. No separate payment will be made for disinfection.

3.02 WATER MAIN CONNECTION DISINFECTION

A. General: If not possible to disinfect piping, valves, and fittings installed at certain connections in manner specified in Article 3.01, Contractor will proceed as follows:

B. Installation of Connections: During installation, observe every precaution to prevent foreign material and trench water from entering piping connections, fittings, and valves.

C. Disinfection: Swab interior of piping connections, fittings, and valves with 5 percent hypochlorite solution. Obtain 5 percent hypochlorite solution by mixing approximately 3 pounds of granulated calcium hypochlorite with 5 gallons of water.

D. Flushing: After pipe, fittings, and valves have been swabbed, thoroughly flush with water in a manner to be addressed in the Wastewater Disposal Plan. During installation, use extreme care to ensure foreign material is kept out of pipe.

END OF SECTION

SECTION 01658

DISINFECTION OF STRUCTURES AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for disinfection of plant structures and equipment.

B. Related Sections:
   1. Special Conditions: Section 00800.

1.02 REFERENCES

A. American National Standards Institute:
   1. ANSI/NSF Standard 60, Listing of Certified Drinking Water Treatment Chemicals – Health Effects.

B. American Water Works Association:
   1. AWWA B300, Standard for Hypochlorites.
   2. AWWA B301, Standard for Liquid Chlorine.
   3. AWWA C653, Disinfection of Water Treatment Plants.

1.03 SCHEDULE OF DISINFECTION

A. Coordination: Equipment is to be disinfected just prior to the Final Mechanical Performance Tests.

B. Item to be Disinfected:
   1. Process Unit.
   2. Contact Basins and Rapid Mixer
   3. Flocculators
   4. Sedimentation Basins
   5. Filters
   6. Filter Influent Flume
   7. Filter Effluent Flume
   8. Clearwell including ceiling
   9. Clarifiers
   10. Thickener

1.04 SUBMITTALS

A. Bacteriological Test Results: See Paragraph 1.05 A.1.

B. Wastewater Disposal Plan: Submit in accordance with Section 00800 - Special Conditions.

1.05 QUALITY ASSURANCE

A. Bacteriological Tests:
   1. See Standard AWWA C653, Sections 1 and 4.
      a. Number of Samples Required: Reference 1.03B above for corresponding items.
         1) 1.03B.1 – One sample each
         2) 1.03B.2 – One sample each
         3) 1.03B.3 – One sample each
         4) 1.03B.4 – One sample each
         5) 1.03B.5 – One sample each
         6) 1.03B.6 – One sample each
         7) 1.03B.7 – One sample each
         8) 1.03B.8 – One sample each
         9) 1.03B.9 – One sample each
         10) 1.03B.10 – One sample each

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Transport, handle and store disinfection products in a manner recommended by respective manufacturers to prevent contamination and deterioration of products.

B. When handling disinfection products, due caution is advisable. Wear gloves, apron, goggles, and suitable vapor mask.

PART 2 PRODUCTS

2.01 MATERIALS

A. Hypochlorites: Standard AWWA B300.

B. Liquid Chlorine: Standard AWWA B301.

C. Provide NSF Standard 60 certified products per Listing of Certified Drinking Water Treatment Chemicals – Health Effects.

PART 3 EXECUTION

3.01 FLUSHING AND DISINFECTING WATER

A. Obtain flushing and disinfecting water for disinfection of structure at water treatment plant from Owner. Refer to Section 00800 - Special Conditions for requirements for a Wastewater Disposal Plan.

B. Incur all costs in utilizing and disposing of flushing and disinfecting water.

C. Owner will not charge for water used to initially flush and disinfect a structure. If any structure has to be reflushed and/or redisinfected, cost of obtaining this additional water from Owner will be at Contractor's expense.

D. Include costs for disinfection of structures and equipment in unit or lump sum prices bid for work as no separate payment will be made for disinfection.

3.02 CLEANING AND PRELIMINARY FLUSHING

A. Clean items to be disinfected of dirt, debris, residual formed on sides of items, and any other foreign material. Thoroughly flush with water prior to disinfection.

3.03 CHLORINATION

A. General: After being thoroughly flushed, disinfect specified structure by chlorination.

B. Form of Chlorine: Apply chlorine in a chlorine gas-water mixture, calcium hypochlorite solution, or chlorine spray solution.

C. Methods of Application:
   1. General: Submit methods of application to Engineer for approval.
   2. Chlorine Gas-Water Mixture: Apply chlorine gas-water mixture by means of a solution feed chlorination device. Provide device with means to prevent backflow of water into chlorine cylinder.
   3. Calcium Hypochlorite Solution: Inject or pump a solution consisting of 5 percent calcium hypochlorite powder and 95 percent water by weight into the lines.
   4. Chlorine Spray Solution: Apply chlorine spray solution, having a concentration of at least 200 ppm. Apply uniformly to all interior surfaces, including equipment by fruit tree sprayers, fire hoses, or other approved equipment. After spraying, fill holding basin to a depth of 6 inches with water containing at least 50 ppm chlorine.

3.04 POINTS OF APPLICATION

A. If chlorine spray solution is not going to be used for basins, inject disinfecting solution into water as it enters each basin or inject into influent main.

3.05 RATE OF APPLICATION

A. Control water to be used in disinfection process to flow slowly into basins.

3.06 PREVENTION OF REVERSE FLOW

A. Exercise great care that strong chlorine solution in areas being treated will not flow back into water supply where water for disinfection is being obtained.

1.04 SUBMITTALS

A. Schedules:
   1. Prepare and submit schedules and procedures to Engineer for testing water mains making up different parts of Project. Submit schedule and procedure a minimum of seven (7) days prior to each test.

1.05 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Where any section of water main is provided with concrete thrust blocking, do not make the hydrostatic pressure test until at least five (5) days after concrete is placed.

B. Operational Requirements:
   1. An Owner's representative must be present for operating valves required to fill mains for pressure and leakage tests. Valves may only be operated by Owner's personnel.
   2. Schedule pressure and leakage test at least 48 hours in advance of day that test is to be made with Owner.

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect each section of pipe and each pipe fitting before installation in conformance with inspection requirements of appropriate standard.

B. Remove rejected pipe and/or fittings from Project.

3.02 HYDROSTATIC TESTING (WATER PIPING SYSTEMS AND CHEMICAL FEED LINES)

A. General: Conduct pressure and leakage tests specified so that each pipeline installed in Project is tested to Engineer's satisfaction.
   1. Provide test pump, pipe connection to main, and all necessary tools, materials and equipment, except the gauge, required for the main testing.
   2. The Owner will furnish the test gauge.
   3. Hydrostatic testing equipment and testing installation is subject to Engineer's approval.
   4. Conduct hydrostatic pressure and leakage tests in presence of and to satisfaction of Engineer.

5. When length of a water main exceeds 1,200 feet, Engineer reserves right to require that water main be tested in sections. Lengths of each section will be determined by Engineer.

B. Preparation:
   1. For underground pipe, either completely backfill trench or partially backfill trench over center section of each pipe length prior to carrying out pressure test. Engineer reserves right, however, to direct that entire trench be backfilled, if traffic or other local conditions require such action.
   2. Section of water main being tested must be filled with water a minimum of 24 hours before main is tested.
   3. Extreme care must be exercised to ensure that all air is expelled from pipeline during filling of pipe with water.
   4. If necessary, tap main and install corporation stops on main at points of highest elevation so that air can be expelled as pipe is filled with water.
   5. After completion of tests, remove corporation stops and tightly plug taps, unless Owner elects to leave corporation stops in place.
   6. Installation of corporation stops for release of air or water from main will be at Contractor's expense, unless they are retained by Owner for other use.

C. Pressure Test:
   1. After pipeline has been filled with water for 24 hours, conduct a pressure test of at least two (2) hours duration. Test pressures for each section of water main to be tested as specified in Paragraph 1.02 A.1.
   2. Apply the specified test pressure by means of a pump connected to the pipe in a manner satisfactory to the Engineer.
   3. Carefully examine all exposed pipes, joints, fittings, and valves during test, and tighten all joints showing visible leakage. Remove all defective pipe, fittings, and valves from line and replace at no additional expense.
   4. Where trench has been completely backfilled, whether at Contractors option or as required by Engineer, and pressure gauge fails to hold required specified pressure, open the trench at no additional expense to repair any leaks.

D. Leakage Test:
   1. Conduct concurrently with pressure test.
   2. Provide suitable means to measure leakage during pressure test. Keep a record of water added to pipeline to maintain pressure for a period of at least 2 hours.
   3. Define leakage as quantity of water that must be supplied into newly laid pipe, or any valved section of it, to maintain pressure within 5 psi of specified test pressure after air in pipeline has been expelled and pipe filled with water.
   4. No leakage is allowed for inside piping. No section of outside pipeline being tested will be accepted if leakage is greater than that determined by the formula $L = \frac{SD(P)^{1/2}}{133{,}200}$ in which L is the allowable leakage, in gallons per hour; S is the length of the pipe tested in feet; D is the nominal diameter of the pipe, in inches; and P is the average test pressure during the leakage test, in pounds per square inch gauge.

5. Should any test of a section of pipeline disclose leakage greater than that permitted, locate and repair the defective joints and/or pipe at no additional expense. Repair all visible leaks regardless of amount of leakage.

E. Repair and Retest: If a water main or section of water main fails to meet specified test requirements, and needs repaired, retest to demonstrate it meets specified test requirements.

F. Owner will furnish water required for one hydrostatic test of water main at no cost to Contractor. Water for additional tests, if required, will be paid for by Contractor.

G. Include costs for above stated tests in unit or lump sum price or prices bid for Work. No separate payment will be made for pressure or leakage testing.

3.03 AIR TESTING (WASTEWATER, OVERFLOW AND SANITARY SEWER SYSTEMS)

A. Safety Requirements: Observe following safety requirements when conducting air tests.
   1. Securely brace pipe plugs to prevent blowouts.
   2. Completely relieve air pressure from pipeline under test before removing temporary pipeline seals.
   3. Completely relieve air pressure in isolated joint space between bladder seals of Joint Tester prior to deflating bladders.
   4. Permit no one in manholes during testing.

B. Testing Equipment:
   1. Use air compressing apparatus equipped with a control panel with necessary piping, control valves and gauges to control air flow rate to piping section being tested; and to monitor air pressure within piping test section and air pressure within test section seal plugs. To prevent accidental overloading of piping test section, provide air compressing apparatus with an approved pressure relief device set to relieve at 10 psi.
   2. Provide an extra pressure gauge of known accuracy to frequently check test equipment and apparatus.
   3. Air testing equipment and associated testing apparatus is subject to Engineer's approval.
   4. Provide GO-NO-GO Mandrel and incidental equipment for Deflection Test. Mandrel to conform to following requirements:
      a. Cylindrical in shape with not less than nine arms spaced evenly around mandrel.
      b. Minimum contact length of mandrel arms with pipe wall not less than nominal diameter of the pipe being tested.
      c. Mandrel diameter 95% of inside pipe diameter.

C. Cleaning Prior to Tests: Before tests are conducted, clean piping including braces and service connections until free of dirt or silt or construction debris.

D. Initial Section Test: To demonstrate acceptability of installed pipe materials and workmanship, construct and air test on pipeline section from manhole to manhole using pipe provided in Contract. Pretesting such section prior to actual Initial Section Test is not be permitted.
   1. Conduct Initial Section Test in same manner as Line Acceptance Test specified in following paragraph.
   2. Conduct Initial Section Test for each size and type pipe material used on Project prior to continued installation of same size and type of pipe.
   3. Provide pipe manufacturer's representation during laying, backfilling and testing of Initial Sections Test.

E. Line Acceptance Test:
   1. After a section of pipeline is constructed between adjacent manholes, backfilled and successfully cleaned, perform a low pressure air "Line Acceptance Test" in accordance with listed standards and the following:
      a. Seal piping at upstream and downstream manholes with pneumatic type plugs. Test plug seal before actual use by testing plugs outside trench in one length of pipe pressurized to maximum anticipated testing pressure. Plugs are to hold without bracing and show no movement.
      b. Introduce low pressure air slowly into sealed pipe section until internal air pressure is 4 psig greater than average ground water pressure acting on pipe.
      c. Allow two minutes minimum for air temperature to stabilize, adding only required air to maintain pressure.
      d. After stabilization period (3.5 psig minimum in pipe) disconnect air supply and determine rate of air loss by measuring time interval required for 3.5 psig to decrease to 2.5 psig greater than average groundwater pressure acting on pipe.
      e. To determine groundwater pressure acting on pipe being tested, divide height in feet of groundwater above invert of pipe by 2.3. Add result to previously specified test pressures (i.e., if maximum groundwater height is 11.5 feet above pipe invert, groundwater pressure is 5 psig. This increases the 3.5 psig and 2.5 psig to 8.5 psig and 7.5 psig, respectively.) Test pressure not to exceed 120 psig regardless of height of groundwater over pipe.
      f. Consider pipe line "Acceptable" when a 1.0 psig pressure drop does not occur within test time specified in Air Test Table at end of this Section.
      g. Standards:
         1) DIP: ASTM C924.

F. Infiltration Test: In addition to air tests specified previously, conduct infiltration tests at such time and manner required by Engineer.
   1. Infiltration rate of groundwater or other water into pipe line, including manhole bases and walls, exceeding 200 gallons per inch diameter per mile of pipe line per day during periods of high groundwater levels will be considered evidence of defective material or improper workmanship.
   2. Make repairs and replacements if necessary, if rate of infiltration exceeds allowable maximum rate.

3. Regardless of whether rate of leakage exceeds or is below allowable maximum rate, repair all observable leaks in pipe lines.

G. Deflection Test: In addition to air tests and infiltration test, conduct deflection tests on PVC pipe.
   1. Conduct deflection testing not less than 30 days after section of pipe line is backfilled.
      a. Pull mandrel through pipe section manually; powered pulling devices not permitted.
      b. Consider pipe line section which mandrel cannot pass through, to have more than maximum allowable deflection of 5 percent.

H. Repair and Retest: When section or sections of pipe line fails to meet test requirements specified previously:
   1. Determine source or sources of leakage.
   2. Repair or replace defective material and if a result of improper workmanship correct such.
   3. Take up and relay pipe line section that has more than maximum allowable deflection.
   4. Conduct additional tests required to demonstrate that pipe line meets specified test requirements.

I. The Owner reserves the right to retest at his expense any piping throughout duration of Construction Period.
   1. Make repairs as work of this contract to piping found defective by such Owner conducted tests.

END OF SECTION

AIR TEST TABLES																					
MINIMUM HOLDING TIME IN SECONDS REQUIRED FOR PRESSURE TO DROP FROM 3-1/2 TO 2-1/2 PIG (POUNDS PER SQUARE INCH GAUGE)																					
LENGTH OF MAIN IN FEET																					
Pipe Dia.	**	25	50	75	100	125	150	175	200	225	250	275	300	325	350	375	400	425	450	475	500
4"	0	4	9	13	18	22	27	31	36	40	45	49	53	58	62	67	71	76	80	85	89
6"	0	8	16	24	32	41	48	56	64	72	80	88	96	104	112	120	128	136	144	152	160
8"	0	18	36	53	71	89	107	125	142	160	178	196	214	232	249	267	285	303	321	338	356
10"	0	22	45	67	89	111	134	156	178	200	223	245	267	289	312	334	356	378	401	423	445
12"	0	27	53	80	107	134	160	187	214	240	267	294	321	347	374	401	427	454	481	508	534
15"	0	31	63	94	125	157	188	219	250	282	313	344	376	407	438	470	501	532	563	595	626
16"	0	36	71	107	142	178	214	249	285	321	356	392	427	463	499	534	570	605	641	677	712
18"	0	36	72	108	144	180	216	252	288	325	361	397	433	469	505	541	577	613	649	685	721
20"	0	40	81	121	162	202	243	283	324	364	405	445	486	526	567	607	648	688	729	769	809
21"	0	45	89	134	178	223	268	312	357	402	446	491	535	580	625	669	714	759	803	848	892
24"	0	53	107	160	214	267	321	374	427	481	534	588	641	695	748	801	855	908	962	1015	1068
27"	0	62	125	187	250	312	374	437	499	562	624	687	749	811	874	936	999	1061	1123	1186	1248
30"	0	72	143	215	286	358	429	501	572	644	716	787	859	930	1002	1073	1145	1216	1288	1359	1431

Note: For lines more than 30 inch diameter; perform Line Acceptance Test by testing one joint at a time.

a. Equipment: Use joint testing apparatus such as American Logi-Ball Inc., Telespector Corp., Cues, or Cherne Industrial, Inc.
b. Consider joint acceptable when the pressure loss is less than one pound in one minute immediately following air stabilization.
c. Use air pressure for testing joint as previously specified.

SECTION 01700

PROJECT CLOSEOUT

PART 1: GENERAL

1.01 TESTING OF FACILITIES

The CONTRACTOR shall produce a first-class job and all Work shall be tested under operating conditions and pressures and any leaks or malfunctions shall be repaired to the satisfaction of the ENGINEER at no additional expense to the OWNER. This provision with reference to leakage shall also apply to watertightness of buildings.

1.02 CLOSEOUT PROCEDURES

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. Provide submittals to ENGINEER that are required by governing or other authorities. Submit Application for final payment identifying total adjusted Contract sum, previous payments, and sum remaining due.

1.03 FINAL CLEANING

Execute final cleaning prior to final inspection. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces. Clean equipment and fixtures to a sanitary condition. Clean debris from roofs, gutters, downspouts, and drainage systems. Clean site; sweep paved areas, rake clean landscape surfaces. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.04 PROJECT RECORD DOCUMENTS

Maintain on site, one set of the following record documents; record actual revisions to the Work:

1. contract drawings
2. specifications
3. addenda
4. change orders and other modifications to the Contract
5. reviewed shop drawings, product data, and samples

Store record documents separate from documents used for construction. Record information concurrent with construction progress.

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
2. product substitutions or alternates utilized
3. changes made by addenda and modifications

Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:

1. Measured depths of foundations in relation to finish floor datum.
2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
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.

Submit documents to ENGINEER with final Application for Payment.

1.05 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections.

B. Deliver to **project site** and place in location as directed by OWNER; obtain receipt prior to final payment.

1.06 GUARANTEES AND WARRANTIES

The CONTRACTOR expressly warrants that all workmanship and materials performed or furnished under this Contract will conform to the Specifications, Drawings, samples and other applicable descriptions furnished or adopted by the CONTRACTOR and with all applicable laws, provisions and requirements of the Contract Documents. The CONTRACTOR shall remedy any defects due to faulty materials or workmanship which shall appear within a period of one (1) year from the date of acceptance of the work hereunder and pay for any damage to other work resulting therefrom. The OWNER shall give notice of observed defects with reasonable promptness. The CONTRACTOR warranty hereunder is in addition to, and not in limitation of, any obligations found elsewhere in the Contract Documents, any special guarantees provided by the CONTRACTOR or his suppliers, and any obligations imposed by law.

In addition to the above requirements, the CONTRACTOR shall assign material and equipment guarantees and warranties from all manufacturers and suppliers to the OWNER and deliver copies of such guarantees and warranties and the assignments thereof to the OWNER in order to assure the OWNER of the full benefit of such guarantees and warranties.

1.07 RESTORATION

The CONTRACTOR shall restore and/or replace paving, curbing, sidewalks, gutters, shrubbery, fences, sod or other disturbed surfaces and structures to a condition equal to that before the work began and to the satisfaction of the ENGINEER and shall furnish all labor and materials incidental thereto.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

End of Section

SECTION 02082

MANHOLES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of constructing precast concrete, cylindrical, manhole components and accessories.

B. Related Sections:
   1. Trenching: Section 02324.
   2. Cast-In-Place Concrete: Section 03300.
   3. Grouts: Section 03600.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO Standards as referenced throughout these Specifications.

B. American Society for Testing and Materials.
   1. ASTM A 48, Specification for Gray Iron Castings.
   2. ASTMA276, Specification for Stainless and Heat-Resisting Steel Bars and Shapes.
   3. ASTM A307, Specification for Carbon Steel Externally Threaded Standard Fasteners.
   4. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   5. ASTM C144, Specification for Aggregate for Masonry Mortar.
   6. ASTM C150, Specification for Portland Cement.
   7. ASTM C207, Specification for Hydrated Lime for Masonry Purposes.
   8. ASTM C270, Specification for Mortar for Unit Masonry.
   9. ASTM C361, Specification for Reinforced Concrete Low-Head Pressure Pipe.
   10. ASTM C443, Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
   11. ASTM C478, Specification for Precast Reinforced Concrete Manhole Sections.
   12. ASTM C923, Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes.
   13. ASTM C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   14. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
   15. ASTM D2240, Test Method for Rubber Property-Durometer Hardness.
   16. ASTM D4101, Specification for Propylene Plastic Injection and Extrusion Materials.

C. American Water Works Association:
   1. AWWA C302, AWWA Standard for Reinforced Concrete Water Pipe-Noncylinder Type, Not Prestressed.

1.03 SUBMITTALS

A. Shop Drawings and Product Data: Submit manufacturer's published detail drawings, modified to suit design conditions if required, catalog cuts and Contractor prepared drawings as applicable.

B. Certificates: Submit certified records or reports of results of shop tests with such records or reports containing a sworn statement that shop tests have been made as specified.
   1. Submit manufacturer's sworn certification that components and products will be manufactured in accordance with specified reference standards for components and products.

1.04 QUALITY ASSURANCE

A. Quality Control: Maintain uniform quality of products and component compatibility by using the products of one manufacturer for precast reinforced concrete manholes.

B. Certifications:
   1. Obtain certificate of materials and construction compliance with ASTM C478 from the precast reinforced concrete manhole manufacturer. Submit this certificate as part of required submittals.
   2. Obtain certificate of material and construction compliance with ASTM A48, Class 30 tensile strength from the manhole frame and cover manufacturer. Furnish certification that tensile test bars were from same pour as castings. Submit the certificate as part of required submittals.

1.05 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling: Transport and handle precast reinforced concrete manhole components, and other products specified herein, in a manner recommended by their respective manufacturers to prevent damage and defects.
   1. Through-wall lifting holes are not permitted in manhole component construction.

B. Storage: Store precast reinforced concrete manhole components in accordance with their manufacturer's recommendations to prevent joint damage and contamination. Exercise such care in storage of other specified products as recommended by their respective manufacturers.

1.06 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
   1. Do not set or construct manhole bases on subgrade containing frost.

2. To improve workability of Preformed Plastic Sealing Compound during cold weather, store at temperature above 70 degrees F or artificially warm compound in a manner as recommended by manufacturer.
3. During warm weather, stiffen Preformed Plastic Sealing Compound as recommended by the manufacturer.

PART 2 PRODUCTS

2.01 BASIC MATERIALS

A. Cast-In-Place Concrete Products: As specified in Section 03300.
   1. Use Class A (4000 psi) quality concrete, unless indicated otherwise on the Drawings.

B. Non-Shrink Non-Metallic Grout: As specified in Section 03600.

C. Waterproofed Mortar: Conforming to requirements of ASTM C270 for Type M, 2500 psi. Parts by volume include: One part cement, 1/4 part lime, and sand at not less than 2-1/4 nor more than three times the sum of the volumes of cement and lime used and of the following materials:
   1. Waterproofing Agent: Medusa Waterproofing Powder by Medusa Portland Cement Co.; Hydratite by Grace Construction Materials; or Hydrolox by Chem-Master Corp. Add the Medusa product in the ratio of two pounds per bag of cement; add the other products per manufacturer's recommendations.
   2. Portland Cement: Conforming to ASTM C150, Type I.
   3. Hydrated Lime: Conforming to ASTM C207, Type S.
   4. Sand: Conforming to ASTM C144.
   5. Water: Clean and free from deleterious amounts of acids, alkalis, and organic materials.

D. Epoxy Bonding Compound: Provide a high-modulus, low viscosity, moisture insensitive epoxy adhesive having the following characteristics.
   1. Mix Ratio: 100 percent solids, two-component; mixed one part by volume component B to two parts by volume component A.
   2. Ultimate Compressive Strength: 13,000 psi after cure at 73 degrees F. and 50 percent relative humidity determined in accordance with ASTM D695.
   3. Acceptable Manufacturers:
      a. Sika Corporation: Sikadur Hi-Mod.
      b. Euclid Chemical Company; No. 452 Epoxy System.
      c. A. C. Horn, Inc.; Epoxtite Binder.

E. Manhole Steps: The Contractor is permitted the option to provide one type of manhole step in the Project as selected from the step types and designs below:
   1. Aluminum Step: Aluminum Alloy AA Designation 6061-T6. Coat that portion of aluminum step being embedded in concrete with heavy bodied bituminous paint.

2. Reinforced Plastic Step: Composed of a 1/2 inch Grade 60, ASTM A615 deformed steel reinforcing bar completely encapsulated in Grade 49108, ASTM D4101 polypropylene copolymer compound, Type II.
   a. Acceptable Manufacturers:
      1) M. A. Industries, Inc., Type PS2-B.

F. Manhole Frame and Cover: Gray iron castings conforming to ASTM A48, Class No. 35B, designed for AASHTO Highway Loading Class H-20. Provide castings of uniform quality, free from blowholes, porosity, hard spots, shrinkage distortion or other defects. Frame and cover design and dimensions are as indicated on Drawings.
   1. Finish: Bearing surfaces machined to prevent rocking and rattling under traffic. Casting finished to meet AASHTO Specification M 306, 4.3.3. Painting, Welding, Plugging not allowed.
   2. Identification: Cast the applicable word WATER, STORM, WASTEWATER, DRAIN, or other as indicated on Drawings or required by Engineer, integrally on cover in two inch size raised letters.
   3. Frame Hold-down Bolts: Conforming to ASTM A307.
   4. Cover Hold-down Bolts: AISI Type 316 stainless steel conforming to ASTM A276 for bolts and washers, or manufacturer's standard bronze bolts and washers.
   5. O-ring Cover Gasket: One piece O-ring gasket factory installed in a machined rectangular or dovetail groove in the bearing surface of the cover.
      a. Gasket material of neoprene composition having good abrasion resistance, low compression set, Type D 40 durometer hardness determined in accordance with ASTM D2240.
      b. Gluing of gasket is not permitted.

G. Manhole Component (Section-to-Section) Seals: The Contractor is permitted the option to provide one type of manhole component seal in the Project as selected from seal types specified below, except where required otherwise on the Drawings:
   1. Preformed Plastic Sealing Compound: Flexible rope gasket of butyl rubber material meeting or exceeding all requirements of ASTM C990 and AASHTO M198, extruded in rectangular or square shapes and provided in rolls on coated release paper.
      a. Dimensions: Size the cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference of each manhole section joint when joint is completed.
      b. Acceptable Manufacturers:
         1) Press-Seal Gasket Corporation, EZ-STIK.
         2) Hamilton Kent Manufacturing Company; KENT-SEAL NO. 2.
         3) Continental Concrete Products, Inc., PRO-STIK.
         4) Henry Company; RUB'R-NEK.
   2. Rubber Compression Gasket: Of material composition conforming to ASTM C361 or ASTM C443.

H. Sleeve Type Pipe Seal: Use sleeve type pipe seal in making a core-drilled connection of piping to existing manholes or structures. Pipe seal construction as follows:

1. In general, the pipe seal shall conform to the requirements of ASTM C923 and shall incorporate a positive compression fit of the gasket to both the manhole and the pipe.
2. Acceptable Manufacturers:
   a. Press-Seal Gasket Corp.; PSX Seal.
   b. NPC Inc.; Kor-N-Seal.
   c. A-LOK Products, Inc.

2.02 PRECAST REINFORCED CONCRETE MANHOLE COMPONENTS

A. Materials and Fabrication: Conforming to requirements specified in ASTM C478 except as follows:
   1. Concrete: Composition and compressive strength conforming to ASTM C478 except use Type II or Type III cement in manhole components and increase compressive strength to 4500 psi (at 28 days) in precast bases.
   2. Casting and Curing: Wet cast and steam curing process in accordance with Section 3.6.11 and 3.7.2 of AWWA C302.
   3. Manhole Steps: Factory installed in manhole components, prealigned vertically, spaced on equal centers, and located the minimum distance from ends of risers and top sections as indicated on Drawings.
   4. Manhole Component Seals: As specified previously. Manhole component joints factory formed for self-centering concrete to concrete bearing employing either a rubber compression gasket or preformed plastic sealing compound.
   5. Manhole Component Design: Designs shall conform to ASTM C478. Base, tapered and straight riser section, and top section dimensions and diameters, not consistent with ASTM C478, are as indicated on Drawings.
   6. Lifting Holes and Lugs: Through-wall lifting holes not permitted in manhole component construction. Factory-install lifting keys or lugs integrally in manhole components.

B. Precast Base and Riser Sections: Design, materials and construction as specified previously under Materials and Fabrication.
   1. Pipe Openings: Provide precast base sections with custom preformed pipe openings with integral pipe seals. Preform the pipe opening to accommodate the type of pipe and pipe opening seal required.
   2. Prefabricated Pipe Opening Seals: Provide precast base sections with resilient gaskets of the types and designs which conform to the requirements specified in ASTM C923.

C. Precast Top Sections: Designs as required by the Drawings, and of materials and construction as specified herein, except additional and differing requirements as follows:
   1. Hold Down Bolt Inserts: Factory cast the inserts in the top section with no fewer than two 3/4-inch threaded inserts or slotted inserts to accommodate manhole frame hold down bolts. Provide threaded inserts of three inches depth and designed for an ultimate load in tension of 12,500 pounds. Inserts factory

plugged for shipping. Coordinate insert locations in the top sections to match the bolt hole locations in the manhole cover frames.

2. Eccentric Cone Tops: Provide precast tops of the same minimum wall thickness and with same area of circumferential steel reinforcement as riser sections.
3. Flat Slab Tops: Thickness versus diameter is as indicated on the Drawings. Tops factory formed to properly accept and support required manhole cover frame and properly formed underside to join the top section to the riser section in a matching joint.

D. Precast Grade Rings: Provide one-piece design (two-piece design not acceptable) precast concrete leveling and adjusting units of three inches or four inches thickness, and of materials and construction as specified previously under Materials and Fabrication.
   1. Provide precast grade rings with hold down bolt holes matching location of bolt holes in the cast iron manhole cover frame.
   2. The grade ring design shall provide for full bearing of the cast iron manhole cover frame.

E. Dampproofing Coating: Provide asphalt compound coating of either the solvent type or the emulsion type. However, mixtures of the two types in the Project is not permitted.
   1. Solvent Type: Brush or spray-on asphalt compound, cold-applied.
   2. Emulsion-Type: Brush or spray-on asphalt-base, clay emulsion with fibers, cold-applied.
   3. Acceptable Manufacturers:
      a. W. R. Meadows, Inc.; SEALMASTIC.
      b. Coopers Creek; Coopers Black.
      c. Tnemec; 46-465.
   4. Application: The coating may be either shop or field applied. Apply coating to the exterior of manhole components.
      a. Apply coating in two coats at the rate of 75 to 100 square feet per gallon per coat. Allow 24 hours drying between coats.

2.03 SOURCE QUALITY CONTROL

A. Tests, Inspection: As a condition of the Contract, certain materials require periodic testing according to methods referenced, or as required by the Engineer.
   1. Shop Tests:
      a. Manhole component manufacturers must be equipped to, and will perform the number of tests Engineer deems necessary to establish quality of proposed manhole components.
      b. Have manufacturers furnish to the Engineer certified test records or reports with sworn statement of tests made as specified.
   2. Precast Reinforced Concrete Manholes: Conduct tests as specified in ASTM C478.
   3. Manhole Frames and Covers: Test for AASHTO H-20 highway loading. Test one manhole cover of each design submitted for approval.

4. Engineer reserves the right to accept certified test records or reports of previously conducted tests.

PART 3 EXECUTION

3.01 EXAMINATION

A. Field Inspection: Inspect precast reinforced concrete manhole components in accordance with requirements of ASTM C478 regarding repairable defects and defects subject to rejection by the Engineer.

3.02 PREPARATION

A. Earthwork: Perform earthwork for manhole installation as specified in Section 02324 and according to the following:
   1. Protection: During the earthwork operations, keep pipe and manhole interiors cleared of debris as construction progresses.

B. Dampproofing Coating Touch-Up: Touch-up chipped, cracked, or abraded surfaces and finished joints with two coats of the factory applied dampproofing coating material.
   1. Bring coating materials for touch up and field coating to the job site in the original sealed and labeled containers of the manufacturer.

3.03 MANHOLE CONSTRUCTION METHODS

A. Precast Concrete Manhole Base Installation: Install precast base on a 6-inch deep compacted layer of aggregate meeting requirements of aggregate backfill as specified in Section 02324.
   1. Set pipe in the Prefabricated Pipe Opening Seals so that an equal annular space is created on the interior and exterior of the wall of the manhole base section.
   2. Following pipe installation through the seal, grout the annular space at the pipe connection, on both sides of the wall, to the spring line of the the pipe. Finish the grout smooth and flush with face of manhole.

B. Length of Pipe Connections into Manholes: Use pipes no longer than five feet in length when connecting into manholes through Prefabricated Pipe Opening Seals.
   1. For other types of pipe connections into manholes, use pipes of such length that a pipe joint is provided at the outside edge of manhole base or wall as applicable. Also use pipes no longer than 6 feet in length for first pipe joined thereto.

C. Concrete Channel Fill: Field pour and form concrete channel fill for each manhole base except in the case where precast bases are used, factory preformed channels may be provided.
   1. Form inverts directly in concrete channel fill.
   2. Accurately shape invert to a semi-circular bottom conforming to inside of connecting pipes, and steel trowel finish to a smooth dense surface.
   3. Make changes in size and grade gradually.

4. Make changes in direction of entering piping and branches to a true curve of as large a radius as manhole size will permit.
5. Make slopes gradual outside the invert channels.
6. Use Class B (3000 psi) concrete as specified in Section 03300, unless indicated otherwise on Drawings.
7. When precast bases with preformed channels are used, fill the annular space at the pipe connections, on both sides of the wall, to assure flow through the channel and bring grout up to the spring line of the pipe.
   a. Use Non-Shrink Non-Metallic grout as specified in Section 03600.

D. Manhole Wall Installation: Provide precast reinforced concrete straight riser, tapered riser and top sections necessary to construct complete manholes. Fit the different manhole components together to permit watertight jointing and true vertical alignment of manhole steps.
   1. If rubber compression gaskets are used between sections, install gaskets and join sections in accordance with written instructions of manhole component manufacturer.
   2. If Preformed Plastic Sealing Compound is used between sections, install sealing compound in accordance with manufacturer's recommendations, and join sections in accordance with written instructions of manhole component manufacturer.
      a. Prime joint surfaces if required by sealing compound manufacturer.
      b. If sealing compound is installed in advance of section joining, leave exposed half of two piece protective wrapper in place until just prior to section joining.
      c. Use sealing compound as the sole element utilized in sealing section joints from internal and external hydrostatic pressure.
      d. Arrange and pay for the sealing compound manufacturer's representative to be present for first installation of manhole sections to instruct workmen on proper installation methods of sealing compound and to be present while manhole sections are being installed.
      e. Following manhole section installation, trowel sealing compound surface smooth and flush with interior face of manhole.
      f. Make pipe connections into manhole walls as specified for pipes connecting into manhole bases.

E. Lifting Recess Sealing: Seal with properly designed tapered rubber plugs. Drive plugs into recesses in such manner to render them completely water and air tight. Sealing of lifting recesses with grout not permitted.

F. Manhole Frame and Cover Installation: Where required, make final adjustment of frame to elevation using Grade Rings. Set manhole frame and cover to conform to roadway grade and crown. Set top of manhole frame and cover 1/8-inch below finished paving elevation.
   1. Precast Concrete Grade Ring: Wet, but do not saturate the grade rings immediately before laying. Pre-set grade rings to proper plane and elevation using wedges or blocks of cementitious material not exceeding the joint thickness. No more than four wedges or blocks per grade ring permitted. Incorporate

wedges or blocks in fresh mortar in a manner to completely encase each. Mortar thickness not to exceed 3/4-inch maximum and 3/8-inch minimum. Crown fresh mortar to produce squeeze-out between grade rings. Tool exposed joints with appropriately shaped tool and compact mortar edge into joints. Clean off excess mortar prior to initial mortar set.

2. Cast Iron Manhole Frame and Cover Anchorage: Anchor manhole frames in place on manhole top section, or on leveling units, after installing 1/2-inch thick preformed plastic sealing compound on bearing surface of manhole frame. Remove excess sealing compound squeeze-out after manhole frame is bolted in place.
   a. Anchor Bolt Length: Size bolts according to the following:
      1) Sufficient length to properly pass through leveling units, if any.
      2) Sufficient length to engage full depth of manhole top section inserts.
      3) Sufficient length to allow enough threaded end to pass through manhole frame to properly tighten nut and washer.
   b. Tighten manhole frame bolts after mortar has cured.
   c. Install manhole covers using the proper bolts as provided with the covers for the waterproof installations.

3.04 FIELD QUALITY CONTROL

A. General: Make a visual inspection of each manhole constructed to ensure compliance with installation requirements.

END OF SECTION

SECTION 02083

CHAMBERS, VAULTS AND TANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for rectangular or square precast concrete structures and appurtenances.

B. Related Sections:
   1. Trenching: Section 02324.
   2. Cast-In-Place Concrete: Section 03300.
   3. Grouts: Section 03600.
   4. Chemical Resistant Coatings: Section 09967.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials:
   1. AASHTO Standards as referenced throughout Specifications.

B. American Society for Testing and Materials:
   1. ASTM A615, Deformed and Plain Billet-Steel Bars For Concrete Reinforcement.
   2. A.STM C990, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
   3. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.
   4. ASTM D4101, Propylene Plastic Injection and Extrusion Materials, Spec. for.

C. Kentucky Transportation Cabinet (KYTC):
   1. Standard Specifications for Road and Bridge Construction:
      a. Section 805, Coarse Aggregates.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Structure Compressive Strength: 5,000 psi minimum strength at 28 days.

B. Design Loading:
   1. Design loadings to include dead loads, live loads, impact loads due to water table, and other loads placed on structure.
   2. Design live loading for AASHTO H-20 or HS-20 as indicated on Drawings. Designed wheel load is 16 kips. Live load is load producing maximum shear and bending moments in structure.

C. Contractor Option: Certain reinforced concrete components indicated on Drawings may be either prefabricated manufactured products or field cast-in-place. However, in either case, attain compressive strength specified.

D. Field Cast Option: Conform to requirements of Section 03300.

1.04 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Manufacturer's published detail drawings, modified to suit design conditions if required, and Contractor prepared drawings as applicable.
   2. Manufacturer's descriptive literature and specifications covering product specified. Include installation information.
   3. Shop Drawings to indicate types of materials, dimensions and details including location of reinforcement, inserts, anchors, connections, accessories, joints, openings, and setting details.

B. Certificates:
   1. Certified records or reports of results of shop tests, such records or reports to contain a sworn statement that shop tests have been made as specified.
   2. Manufacturer's sworn certification that components and products will be manufactured in accordance with specified reference standards for components and products.

C. Design Calculations: Submit structural calculations for structures furnished under this Section. Have calculations sealed and signed by a Registered Professional Engineer.

1.05 DELIVERY, STORAGE AND HANDLING

A. Transport and unload precast concrete members to prevent damage.

B. Store on wood sleepers in position to prevent warp, twist or cracking.

C. Lift precast concrete members with slings of nylon, steel cable or chain looped to balance and properly carry members.

PART 2 PRODUCTS

2.01 BASIC MATERIALS

A. Cast-In-Place Concrete Products: As specified in Section 03300.

B. Non-Shrink Non-Metallic Grout: As specified in Section 03605.

C. Epoxy Bonding Compound: Provide a high-modulus, low viscosity, moisture insensitive epoxy adhesive having the following characteristics.
   1. Mix Ratio: 100 percent solids, two-component; mixed one part by volume component B to two parts by volume component A.
   2. Ultimate Compressive Strength: 13,000 psi after cure at 73 degrees F. and 50 percent relative humidity determined in accordance with ASTM D695.
   3. Acceptable Manufacturers:
      a. Sika Corporation: Sikadur Hi-Mod.

b. Euclid Chemical Company; No. 452 Epoxy System.
c. A. C. Horn, Inc.; Epoxtite Binder.

D. Chamber Component (Section-to-Section) Seals:
1. Preformed Plastic Sealing Compound: Flexible rope gasket of butyl rubber material meeting or exceeding all requirements of ASTM C990 and AASHTO M198, extruded in rectangular or square shapes and provided in rolls on coated release paper.
a. Dimensions: Size the cross-section of rope form to provide squeeze-out of material around entire interior and exterior circumference of each chamber section joint when joint is completed.
b. Acceptable Manufacturers:
1) Press-Seal Gasket Corporation, EZ-STIK.
2) Hamilton Kent Manufacturing Company; KENT-SEAL NO. 2.
3) Continental Concrete Products, Inc., PRO-STIK.
4) Henry Company; RUB'R-NEK.

E. Dampproofing Coating: Provide asphalt compound coating of either the solvent type or the emulsion type. However, mixtures of the two types in the Project is not permitted.
1. Solvent Type: Brush or spray-on asphalt compound, cold-applied.
2. Emulsion-Type: Brush or spray-on asphalt-base, clay emulsion with fibers, cold-applied.
3. Acceptable Manufacturers:
a. W. R. Meadows, Inc.; SEALMASTIC.
b. Coopers Creek; Coopers Black.
c. Tnemec; 46-465.
4. Application: The coating may be either shop or field applied. Apply coating to the exterior of manhole components.
a. Apply coating in two coats at the rate of 75 to 100 square feet per gallon per coat. Allow 24 hours drying between coats.

F. Chemical Resistant Coating (Chemical Manholes and Spill Containment Valve Manhole): As specified in Section 09967.

G. Manhole Steps: Provide steps with minimum width of 10 inches, minimum projection from wall of 5-3/8 inches, unless indicated otherwise on Drawings.
1. Aluminum Step: Aluminum alloy AA designation 6061-T6, of design indicated on Drawings. Coat portion of aluminum step being embedded in concrete with heavy bodied bituminous paint.
2. Reinforced Plastic Step: Composed of a 1/2 inch Grade 60, ASTM A615 deformed steel reinforcing bar completely encapsulated in polypropylene copolymer compound conforming to ASTM D4101; M. A. Industries, Inc., Type PS4l.

H. Ladder Up Safety Post: Telescoping tubular steel with stainless steel spring balance mechanism. Provide safety post at locations indicated on Drawings.

1. Acceptable Manufacturer:
   a. Bilco Company.

I. Aluminum Access Doors (Watertight/Drainable): Type and size as indicated on the Drawings, and constructed of materials and components as follows:
   1. Door Leaf(s): 1/4 inch aluminum diamond plate.
      a. Designed for H-20 reinforcing for 16,000 pound wheel loading.
   2. Channel Frame: 1/4 inch aluminum with an anchor flange around the perimeter. Frame exterior factory-finished with bituminous coating.
   3. Door(s): Equip with heavy forge brass hinges, stainless steel pins, spring operators and automatic hold-open arm with release handle.
      a. Flush lift handle.
      b. Removable exterior latch handle.
   4. Lock:
      a. Cylinder lock with keyway protected by a threaded cover plug (with 4 keys).
      b. Provide keys for multiple hatches keyed alike. Coordinate Owner's keying requirements (if any) for locks.
   5. Drainage Coupling: Locate a l-l/2 inch drainage coupling in the corner of the channel frame.
   6. Hardware: Stainless Steel.
   7. Acceptable manufacturers:
      a. The Bilco Company.

J. Wall Sleeve and Seal: Provide factory cast thermoplastic wall sleeves and modular wall seals. Size as indicated on Drawings. Wall seals to have type 316 stainless steel hardware.
   1. Thunderline Corp.

K. Aggregate Backfill: Crushed Stone Base conforming to KYTC Section 805.

2.02 FABRICATION

A. Cast precast concrete members in forms constructed to required dimensions, plumb, straight and mortar tight.

B. Cast and cure precast concrete members in accordance with American Concrete Institute recommended practices referenced in Section 03300.

PART 3 EXECUTION

3.01 PREPARATION

A. Keep pipe and chamber interiors cleared of debris as construction progresses.

B. Earthwork: Perform earthwork for chamber installation as specified in Section 02324, and according to following:
   1. Make excavations for chambers to a nearly vertical plane beginning at bottom of excavation 1 foot beyond chamber base outside dimensions.

C. Coating Touch-Up: Touch-up chipped, cracked, or abraded surfaces and finish joints with two coats of particular coating material.

3.02 CONSTRUCTION METHODS

A. Precast Concrete Bases: Install bases on a 6 inch deep compacted layer of aggregate backfill as specified previously in Section 02324.

B. Chamber Erection: Fit chamber components together to permit watertight jointing.
   1. Install sealing compound in accordance with manufacturer's recommendations, and join sections in accordance with written instructions of precast chamber component manufacturer.
      a. Prime joint surfaces if required by preformed sealing compound manufacturer.
      b. If sealing compound is installed in advance of section joining, leave exposed half of two piece protective wrapper in place until just prior to section joining.
      c. Use preformed sealing compound as sole element utilized in sealing section joints from internal and external hydrostatic pressure.
      d. Following chamber section installation, trowel sealing compound surface smooth and flush with interior face of chamber.

3.03 FIELD QUALITY CONTROL

A. Conduct compressive strength test as specified under Field Quality Control in Section 03300.

B. Submit certified test results indicating level of compressive strength requirements as being met.

END OF SECTION

SECTION 02200

SITE PREPARATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Clearing, grubbing, and stripping topsoil from work areas to limits indicated on Drawings.

B. Related Sections:
   1. Rough Grading: Section 02311.
   2. Erosion and Sediment Control: Section 02370.

1.02 REFERENCES

A. American Association of State Highways and Transportation Officials.
   1. AASHTO T 194, Standard Methods of Test for Determination of Organic Matter in Soils by Wet Combustion.

1.03 PROJECT CONDITIONS

A. Environmental Requirements: Exercise necessary means and methods to control dust on site during performance of work.

B. Burning: Perform on site and off site burning only if permitted by governing local laws and regulations.

C. Protection:
   1. Preserve structures and objects, including trees and shrubs designated to remain. Means and methods used for protection are discretionary.
   2. Use required protective measures during felling of trees and debris removal to provide for safety of employees and others.

D. Do not clear and grub in or adjacent to existing natural drainage channels unless prepared to proceed immediately with final grading and stabilization.

PART 2 PRODUCTS

2.01 MATERIALS

A. Fill Material: As specified for site grading in Section 02311.

PART 3 EXECUTION

3.01 INSPECTION

A. Prior to performance of actual work, carefully inspect entire site and locate structures, objects, and plant life designated to be preserved.

3.02 PERFORMANCE

A. Implement erosion control measures prior to and during performance of work of this Section. Erosion control as specified in Section 02370.

B. Where embankment is intended, clear and grub area to a depth not less than 6 inches below existing ground.

C. Where landscaping work is intended, clear and grub area to a depth not less than 8 inches below existing ground.

D. Where excavation work is intended, clear and grub area to depths as follows:
   1. Footings: 18 inches.
   2. Walks: 12 inches.
   3. Road and Parking areas: 18 inches.

E. Stump Removal:
   1. Remove stumps and roots completely.
   2. Backfill stump holes in maximum 8 inch layers with fill material previously specified, to density of surrounding earth material.

F. Disposal: Dispose of burnable debris by controlled, supervised burning, local laws and regulations permitting.
   1. Burnable debris can be disposed of along with nonburnable debris off site in a lawful manner.
   2. Dispose of clearing and grubbing debris at a site having current approval for conducting solid waste disposal.
   3. Remove clearing and grubbing debris accumulations daily.
   4. When clearing and grubbing beyond normal working hours, do not allow clearing and grubbing debris to accumulate for more than 48 hours.
   5. Combustible material may be reduced to chips of 1/2 inch maximum size. Chips can be disposed of in areas where erosion control is required, as a substitute for straw mulch.
   6. Do not bury stumps, branches or brush in fill areas.

3.03 STRIPPING

A. Stripping consists of segregating approved topsoil encountered in excavation of project and stockpiling for future use.

B. Topsoil consists of friable loam, reasonably free of subsoil, clay lumps, brush, roots, weeds or other objectionable vegetation, stones or similar objects larger than 1 inch in any dimension, litter, or other material unsuitable or harmful to plant growth. Topsoil to contain not less than 1.5 percent nor more than 20.0 percent organic matter, as determined by AASHTO Designation T 194.

C. Mow or otherwise remove heavy grass, weeds, or other vegetation over areas before stripping. Remove topsoil from area prior to performance of normal excavation. Remove topsoil to its full depth, but adjust equipment and methods to avoid lifting subsoil or other unsuitable material.

D. Strip topsoil from an area approved by Engineer, keep separate from other excavations and stockpile at locations within Right-of-Way or property lines.

E. Do not sell topsoil.

END OF SECTION

SECTION 02210

SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: General requirements for performing subsurface investigation.

1.02 LIMITATIONS OF SUBSURFACE INFORMATION INDICATED ON DRAWINGS

A. Certain information regarding reputed presence, size, character and location of existing underground pipe and conduits is indicated on Drawings. There is no certainty of the accuracy of this information, and location of underground piping indicated may be inaccurate, and obstructions other than those indicated may be encountered.

B. Contractor distinctly agrees that neither Owner or Engineer is responsible for correctness or sufficiency of information given:
   1. That in no event is this information to be considered as a part of Contract;
   2. That no claim will be made for delay or extra compensation or damage against Owner or Engineer on account of incorrectness of information given; or on account of insufficiency or absence of information regarding obstruction either revealed or not revealed by Drawings; and
   3. That no claim will be made for relief from any obligation or responsibility under Contract, in case location, size or character of any pipe or other underground structure is not as indicated on Drawings, or in case any pipe or other underground structure is encountered that is not indicated on Drawings.

C. Digging Test Pits:
   1. At locations required by Engineer, or indicated on Drawings, dig test pits to determine location, size, roundness and elevation of existing subsurface utility pipelines, cables or structures. Dig test pits in the presence of an authorized representative of owner of subsurface utility pipelines, cables or structures. No excavation, pipe laying or other work is permitted at above referenced locations without the presence or approval of an authorized representative of owner of subsurface utility.
   2. In locations where new water mains, sewers or storm drains are to be connected to existing facilities, do not order materials and proceed with new construction until digging test pits to determine exact location, size, roundness and elevation of existing utilities. Dig test pits only at locations agreed to by Engineer.
   3. Digging test pits in locations required by Engineer or indicated on Drawings will be categorized as unclassified excavation and backfill. Payment for digging test pits in locations required by Engineer or indicated on Drawings, including pavement removal and replacement, will be made at the Contract unit or lump sum price bid.

4. Test pits or other miscellaneous excavations dug to obtain information on subsurface conditions or underground obstructions without written requirement of Engineer will be at Contractors expense.

PART 2 MATERIALS

NOT USED

PART 3 EXECUTION

NOT USED

END OF SECTION

SECTION 02255

SHORING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision for protection of excavations by sheeting and shoring.

B. Related Sections:
   1. Trenching: Section 02324.

1.02 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Furnish shoring materials and install work conforming to Federal, State and local laws, rules, regulations, requirements, precautions, orders and decrees.
   2. Provide material for sheet piling, sheeting, bracing and shoring and drive or set in place in accordance with Federal, State and local laws for excavations and construction; and as required to protect workers and public, or to maintain trench widths specified in Section 02324, regardless if considered necessary by Contractor.

1.03 PROJECT CONDITIONS

A. Responsibility for Condition of Excavation:
   1. Failure or refusal of Engineer to suggest use of bracing or sheeting, or a better quality, grade, or section, or larger sizes of steel or timber, or to suggest sheeting, bracing, struts, or shoring be left in place, does not relieve Contractor of responsibility concerning condition of excavation or of his obligations under Contract, nor impose liability on Engineer or Owner. Delays, whether caused by action or want of action on part of Contractor, or by act of Engineer, Owner, or their agents, or employees, resulting in keeping of excavation open longer than would otherwise have been necessary, does not relieve Contractor from necessity of properly and adequately protecting excavation from caving or slipping, nor from his obligations under Contract relating to injury to persons or property, nor entitle him to claims for extra compensation.

PART 2 PRODUCTS

2.01 MATERIALS

A. Wood Materials: Use wood sheeting, sheet piling, bracing and shoring in good serviceable condition and timbers of sound condition, free from large or loose knots, and of proper dimensions.

B. Metal Materials: Steel or manufactured aluminum sheet piling and bracing of equal strength may be substituted for wood.

PART 3 EXECUTION

3.01 INSTALLATION

A. Using skilled labor, drive or set sheeting, sheet piling, braces or shores in place and arranged that they may be withdrawn as excavations are backfilled, without injury to piping and structures, and without injury to or settlement of adjacent structures and pavements.

B. Drive sheeting in advance of excavation when tight plank or steel sheeting is required. Make joints of tongue and groove or interlocking type and as watertight as possible.

C. Remove sheeting, bracing and shores as trenches and other excavations are being backfilled, except where and to extent Engineer requires, in writing, it be left in place or where permitted to leave in place at Contractor's own request and cost.
   1. In withdrawing sheeting and sheet piling, exercise care to ensure that voids or holes left by planks as they are withdrawn are backfilled and thoroughly rammed with thin rammers provided especially for that purpose.
   2. Exercise care to carry backfill up evenly on all sides of items installed in excavations.

D. Cut off sheeting or sheet piling left in place as required by Engineer and remove from work portion cut off. No additional compensation allowed for cutting and removal of sheeting or sheet piling left in place.

END OF SECTION

SECTION 02311

ROUGH GRADING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Excavation, backfill and embankment necessary to grade site(s) to lines indicated on Drawings.

B. Related Sections:
1. Site Preparation: Section 02200.
2. Shoring: Section 02255.
3. Finish Grading: Section 02312.
4. Excavation and Fill: Section 02315.
5. Roadway Excavation, Backfill, and Compaction: Section 02336.
6. Erosion and Sediment Control: Section 02370.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials:
1. AASHTO T 99, Moisture-Density Relations of Soils, Using a 5.5 lb. Rammer and a 12 inch Drop.

B. American Society for Testing and Materials:
1. ASTM D422, Standard Test Method for Particle-Size Analysis of Soils.
2. ASTM D698, ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft.-lbf/ft.3).
3. ASTM D1556, Density of Soil in Place by the Sand Cone Method.
4. ASTM D2167, Density of Soil in Place by the Rubber-Balloon Method.
5. ASTM D2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
6. ASTM D4318, Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

1.03 DEFINITIONS

A. Unclassified Excavation: Material removal of any kind in excavation, including Rock Excavation.

B. Subgrade: Prepared earth surfaces where on or over additional materials are placed or work is performed.

1.04 SUBMITTALS

A. Test Reports: Submit for approval complete sieve analysis, compaction density, liquid limit and plastic limit test reports for on site and borrow excavated material desired to

be used for backfill and embankment fill. Test in accordance with specified Reference Standards. For disapproved material, either submit for approval above data for new borrow material, or procedures and materials proposed to be used to obtain approved stabilizations and densities for excavated materials.

B. Blasting Plan:
   1. Submit data concerning proposed blasting operations to Engineer, and utility owners if required.

C. Testing Agency: Submit name and qualifications of Testing Agency performing seismographic tests to Engineer for approval prior to proceeding with blasting operations.

1.05 PROJECT CONDITIONS

A. Classification of Excavated Materials: No consideration will be given to nature of materials encountered in site grading operations. Therefore, as unclassified excavation, no additional payment will be made for difficulties occurring in excavating and handling of materials.

B. Environmental Requirements:
   1. Do not perform grading when soil or weather conditions are unsuitable. Unsuitable conditions include moisture saturated or frozen in place soil and precipitation present on soil or occurring during Work.
   2. Exercise necessary means and methods to control dust on site as well as in off site work areas where excavation and grading are required.
   3. Do not leave site in a dusting condition following work of this Section. If necessary, employ a watering schedule to control dust.
   4. Do not use frozen material in performing work or place materials on frozen surfaces.
   5. When it is necessary to haul soft or wet soil material over roadways, use suitably tight vehicles to prevent spillage. Clear away spillage of materials on roadways caused by hauling at no expense to Owner.
   6. Plan work so as to provide adequate protection during storms with provisions available constantly for preventing flood damage.
   7. Slope trench excavations and embankments to prevent puddling. Control runoff in accordance with Section 02370.

C. Explosives and Blasting: Use and store explosives in accordance with requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees. No blasting permitted within 200 feet of existing water transmission mains, piping, and conduits. Additionally comply with following:
   1. Assume sole responsibility for injury to persons or property as a result of explosives and blasting.
   2. Schedule blasting in proximity of proposed new concrete work prior to placement of concrete.

3. Notify utility owners having structures or other installations above or below ground in proximity to site of work prior to use of explosives. Give notice sufficiently in advance to enable utility owners to take steps necessary to protect their property from injury. Notifying utility owners does not relieve sole responsibility of damage resulting from use of explosives.
4. Provide competent, licensed blaster to supervise blasting.
5. Cease blasting operations when adjacent street paving is damaged. Repair damaged street paving.
6. Employ an independent testing laboratory, acceptable to Engineer, to conduct seismographic tests in conjunction with blasting operations. Tests will be made to establish acceptable blast patterns and procedures, and as often as Engineer deems necessary.
7. Prior to starting work, furnish Engineer data concerning proposed blasting operations. Include location, depth, and area of blast; diameter, spacing, depth, pattern, and inclination of blast holes; type, strength, quantity, column load, and distribution of explosives to be used per hole, per delay, and per blast; sequence and pattern of delays; and description and purpose of special methods to be adopted. Engineer reserves right to limit maximum size of explosive charge.
8. Engineer's acceptance of blasting data and techniques does not relieve responsibility to exercise proper supervision and field judgment and to produce specified results.
9. Blasting is permitted only after proper precautions have been taken for protection of persons, work and property. Control fly rock and material to prevent damage to persons or structures. When directed by Engineer, use blasting mats in areas where overburden has been removed prior to blasting. Provide a positive means of dust control with equipment used for drilling of holes, subject to Engineer's approval.
10. Before blasting within 50 feet of cured concrete, submit and obtain approval of a plan showing relative positions of concrete, area to be blasted and blasting technique to be employed.
11. Perform blasting no closer than 25 feet from existing utilities, transverse crossings and parallel installations, unless utility company relieves this requirement. Before blasting within 150 feet of cured concrete, submit and obtain approval of a plan showing relative positions of concrete, area to be blasted, and blasting technique to be employed. Right is reserved by utility company not to allow blasting in trench adjacent to utility.
12. Use controlled blasting techniques. Modify blasting round as necessary to achieve best obtainable results and to keep air blast over pressure, vibrations and noise within limits specified. Exercise care in drilling and blasting operations to minimize overbreak and blast damage of adjacent unexcavated ground. Assume responsibility to produce a satisfactory excavated surface by determining proper relationships of factors of burden, spacing, depth of charge, quantity, and type of explosive, hole size and delay pattern, and other necessary considerations to achieve required results.
13. Perform blasting operations during normal working hours 7 am to 6 pm prevailing time. In event of an emergency, for example a thunderstorm, prevents a blast

from being made before 6 pm, and holes are loaded, set blast off as soon as safety allows. In event blasting is found necessary during restricted hours, inform Owner and local residents, within hearing and vibration range, prior to firing. In addition, report in writing following day to Engineer, conditions requiring blasting during restricted hours. Impact or impulsive noise from blasting operations is not to exceed 130 dB peak sound pressure level measured at nearest structure or property line. Do not leave blasting materials in hole for extended periods of time.

14. Notify residents within hearing and vibration range, on morning of blasting as well as 72 hours in advance.
15. Store explosives on site only during blasting hours specified in preceding paragraph. Truck explosives to site at start of each work day from a magazine located remote from populated areas. Return surplus explosives to magazine at close of each work day. Locations of magazines on site and parking for explosives trucks will be determined by Engineer.
16. Monitor vibrations by measuring Peak Particle Velocity (PPV) in vicinity of blast at locations approved by Engineer. Provide experienced personnel to operate instrumentation used to monitor air blast overpressure and PPV. Arrange to have an experienced vibrations engineer available to review seismograph and instrumentation calibration data, and to recommend blasting techniques on Project. Data from measurements will be used in controlling blasting operations. PPV, as measured on or at structures in vicinity of blasting operations, is not to exceed two inches per second. Limitations on PPV do not relieve responsibility in ensuring integrity and safety of adjacent structures. PPV is defined as maximum of three velocity components of a vibration measured at any point in three mutually perpendicular directions by a seismograph approved by Engineer, capable of producing a permanent record and capable of internal dynamic calibration. Record air blast overpressure with a peak impact recording instrument having linear frequency response.
17. Furnish, install, and operate at site, an approved thunderstorm monitor and automatic lightning warning device. Make adequate provisions for transmitting alarms from device to locations where electric blasting or preparation for electric blasting is in progress. Locate and install system according to manufacturer's recommendations. Employ qualified personnel to operate and periodically test entire monitoring and alarm system for satisfactory operation, and promptly correct discovered defects. Provide for repair or replacement of facilities damaged by blasting operations at no cost to Owner.

D. Protection: Assume risks attending presence or proximity of overhead or underground public utility and private lines, pipes, conduits and support work, existing structures and property of whatever nature, in or over excavations or adjacent to excavations. Assume complete responsibility for replacement and restitution work of whatever nature to above, as damaged or destroyed by work of this Contract, and at no expense to Owner.
    1. Outside Property Limits or Rights-of-Way: Take necessary precautions to protect trees, shrubs, lawns and other landscaping from damage. Restitution work for damages rests solely with Contractor and at no expense to Owner.

2. Temporary Protective Construction: Erect and maintain without expense to Owner, substantial barricades to exclude pedestrians or vehicles.

E. Borrow Excavation: Where required quantity of backfill exceeds quantity of suitable material excavated within limits of project site and Rights-of-Way, obtain sufficient material to complete backfill at no additional cost to Owner. If borrow excavation is needed, notify Engineer sufficiently in advance of borrow excavation requirements to permit Engineer to verify need for borrow excavation and to view proposed borrow pit. Borrow excavation from outside sources is subject to approval of Engineer. Obtain written consent before use of borrow excavation from outside sources.

F. Excess Materials: No right of property in materials is granted of excess on site materials prior to completion of Site Work. This provision does not relieve responsibility to remove and dispose of surplus excavated materials. Dispose of legally off site, unsuitable materials including sod, stumps, spongy soil as well as excess rock.

G. Accommodation of Traffic: Do not obstruct streets, roads and highways. Unless Municipality, Governing Agency, or Engineer authorizes in writing complete closing of street, road or highway, employ necessary measures at no expense to Owner to keep street, road or highway open and safe for traffic.

H. Excavation Limits: Excavate to lines, grades and slopes indicated on Drawings or to depths and dimensions required to produce a satisfactory foundation surface as determined by Engineer.

I. Slopes of Opencut Excavation: Maintain stable slopes, and comply with OSHA requirements for slopes of opencut excavation. Overexcavation without authorization by Engineer will not be paid for, nor will payment be made for overexcavation and refill. Remove slides of material and repair at no additional cost.
   1. Excavate slopes to angles necessary to ensure safe working conditions and stable slopes.

J. Temporary sheeting, shoring and bracing is as specified in Section 02255.

PART 2 PRODUCTS

2.01 MATERIALS

A. Embankment and Backfill in Areas 5 Feet Beyond Structures (General Fill): Use on site or borrow excavated soil or soil rock material free of topsoil, plant life, lumber, metal, and refuse and meeting following requirements for site grading backfill and embankment 5 feet beyond structures. Rocks contained in suitable material must pass through a 6 inch by 3 inch opening, and not exceed 10 percent of backfill or embankment volume. Provide soil with at least 60 percent passing #4 sieve when tested in accordance with ASTM D422; a liquid limit of not more than 45 and a plasticity index of not more than 25 when tested in accordance with ASTM D4318; and a maximum dry density of not less than 100 pounds per cubic foot.

1. Construction requirements for roadway embankment containing rock are as specified in Section 02336.

B. Backfill and Embankment in Areas Below or within 5 feet of Structures (Select Compacted Fill): On site or borrow excavated soil meeting above requirements for General Fill and embankment areas 5 feet beyond structures, except size of rock not to exceed 3 inches in largest dimension.

PART 3 EXECUTION

3.01 PREPARATION

A. Salvaged Topsoil: Within areas indicated for grading, strip topsoil to depth of suitable topsoil material and stock pile for subsequent topsoiling operations. See Section 02200.
   1. Topsoiling: Perform as work of Finish Grading in Section 02312.

3.02 PERFORMANCE

A. Erosion Control: Implement erosion control measures prior to and during performance of work of this Section. Erosion Control as specified in Section 02370.

B. Vehicle Traffic Area Grading: As specified in Roadway Excavation, Backfill and Compaction: Section 02336.

C. Excavation of Borrow Material: Perform excavation of borrow material in a manner satisfactory to Engineer. Strip borrow pits of brush, trees, roots, grass and other vegetation prior to removal of material for use in backfill. During excavation operation, grade borrow area to ensure free drainage of water from area. Place and maintain erosion control devices after completion of excavation, grade excavated area including side slopes to drain and present a uniformly trim appearance merging into surrounding terrain. After borrowing operations are completed, regrade area, if necessary, to prevent erosion.

D. Removing Obstructions: Where rock is encountered at proposed subgrade elevations and topsoil is required, remove rock for a depth of twelve inches below proposed subgrade.

E. Preparation of Subgrade for Embankments: Perform sufficient in place density tests on supporting material to show that material is in stable condition with proper density. Compact supporting material if necessary.

F. Placement and Compaction of General Fill: Construct embankments, except embankments for roadways and around new structures, in accordance with following paragraphs.
   1. Place fill in lifts no thicker than one foot and compact using approved equipment. Carry whole embankment up evenly to required elevation without breaks or irregularities in material distribution or in formation of layers. Trim embankment

slopes to lines indicated on Drawings and leave in a neat and acceptable condition.

2. Add water to fill not containing sufficient moisture to obtain required compaction. Harrow, or use other approved methods, to work moisture into material until a uniform distribution of moisture is obtained. Fill containing moisture in excess of moisture required to obtain necessary compaction density may not, without written approval, be incorporated in embankment until allowed to dry to a moisture content not greater than two percentage points above optimum for that particular material. Do not place frozen material, ice, or snow in embankments.
3. Fill existing natural or other depressions resulting from site work to level of adjacent ground elevation in manner specified for formation of embankment prior to starting initial embankment layer. Provide material for this operation of type used adjacent to structures.
4. Remove existing embankment foundation material when determined unsatisfactory by Engineer. Backfill areas to original elevation with General Fill, placed and compacted as specified herein.
5. Scarify embankment foundation surface where embankment of three feet or more in height is placed. If compacted surface of any layer of material is determined to be too smooth to bond properly with succeeding layer, loosen surface by harrowing or by other method approved by Engineer before placing succeeding layer.
6. Plow existing embankment foundations having a slope steeper than four to one to provide embankment binding when required by Engineer. On steeper slopes Engineer may require foundation be cut into steps or berms.
7. Compact each lift with at least 5 passes of compaction equipment suitable for material being placed and suitable for requirements of fill. Suitability of equipment for fills to be determined by Engineer based on field performance of equipment. Furnish alternate compaction equipment if Engineer deems equipment being utilized is ineffective or inappropriate for conditions and requirements of fill being placed.
8. During dumping and spreading process, maintain a constant force of workers, adequate to remove and dispose of stones with dimensions greater than 3 inches by 6 inches, roots and debris from embankment materials.
9. During construction, keep top of partially completed embankments shaped and drained continuously.

G. Placement and Compaction of Select Compacted Fill: As specified in Section 02315.

H. Topsoil: As specified in Section 02312.

3.03 FIELD QUALITY CONTROL

A. Field Moisture-Density Tests: When deemed necessary by Engineer, conduct a minimum of two field moisture-density determinations per 500 square feet placed in a horizontal layer at locations designated by Engineer. Field dry density to equal or exceed 95 percent of maximum dry density, and in place moisture content to be within percentage points of optimum moisture contents, as determined per ASTM D698.

1. Moisture content at which maximum density of backfill is obtained with a given compactive effort, AASHTO T 99, is considered optimum moisture content.
2. Field compaction density may be determined by Sand Cone Method ASTM D1556, Rubber Balloon Method ASTM D2167, Nuclear Method ASTM D2922, or other acceptable method as approved by Engineer.

END OF SECTION

SECTION 02312

FINISH GRADING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Placement and supplemental additions to topsoil as required to restore disturbed areas.

1.02 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM C602, Agricultural Liming Materials.

1.03 SUBMITTALS

A. Test Reports: Submit laboratory test reports of soil analysis and supplement recommendations to Engineer for approval prior to adding any soil supplements to topsoil.
   1. Laboratory reports to recommend both grade and application rates of fertilizer, and such other soil supplements as required.
   2. Take sufficient quantity of topsoil samples to give a representative analysis of on-site topsoil and topsoil from outside sources, if any.

B. Soil Supplement Product Certification: Submit certificates certifying such products to have a guaranteed analysis in conformity with Engineer approved laboratory soil supplement recommendations report.

1.04 QUALITY ASSURANCE

A. Quality Control:
   1. Packaged Products to indicate manufacturer's guaranteed analysis on each package and arrive on site as originally packaged and unopened.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver packaged products to site in unopened containers with labels intact and legible.

B. Store packaged products in a manner to prevent moisture damage and other forms of contamination.

1.06 PROJECT CONDITIONS

A. Environmental Requirements: Do not perform work of this Section when soil or weather conditions are unsuitable. Unsuitable conditions include moisture saturated or frozen in place soil and precipitation of any kind present or occurring during work.

B. Existing Conditions: Following performance of related construction and prior to Finish Grading, perform debris removal and site leveling as necessary in preparation for Finish Grading. Dispose of debris legally off site.

C. Dust Control: Exercise necessary means and methods to control dust on site as well as in off site work areas where Topsoiling and Finish Grading are required.

PART 2 PRODUCTS

2.01 MATERIALS

A. Topsoil: Use fertile, friable, natural, productive surface soil as is available on site (if any). Use topsoil free of subsoil, clay, stones or similar hard objects larger than 1 inch in greatest dimension and partially disintegrated debris and materials toxic or harmful to growth. Acceptable topsoil to contain organic matter in range of 1.5 percent to 20 percent.

B. Borrow Topsoil: Use productive topsoils from Contractor's source and of a quality meeting requirements specified above for Topsoil. Furnish any additional topsoil necessary to complete work at no additional expense to Owner.

2.02 SOIL SUPPLEMENT MATERIALS

A. Agricultural Liming Materials: Products containing calcium and magnesium compounds capable of neutralizing soil acidity and containing not less than 80 percent of total carbonates. Use liming materials meeting requirements of ASTM C602 and conforming to applicable state liming material regulations.

B. Fertilizer: Commercial fertilizer of uniform composition, free-flowing and in conformity with applicable state fertilizer laws.
   1. Analysis: As recommended by laboratory soil supplement recommendations report.

PART 3 EXECUTION

3.01 PREPARATION

A. Prepare subsoil surface for finish grading by dressing and shaping to provide for uniform placement of topsoil.

B. Prepare subsoil surface for topsoiling by loosening to a depth of 4 inches and dressing and shaping to provide for uniform placement of topsoil.

C. Remove surface rock or other foreign objects exceeding 3 inches in greatest dimension. Dispose of rock and debris off site in a lawful manner.

3.02 PERFORMANCE

A. Placement: Place topsoil over areas indicated for new grading contours. Ensure construction work in topsoiled areas is completed before topsoil placement. Observe precautions as follows:
   1. Do not place topsoil over areas indicated to receive paving or walkways.
   2. Do not work topsoil while frozen or wet. Do not work topsoil into a dusting condition. Moisten topsoil to prevent a dust nuisance.
   3. Scarify subsoil to a depth of 4 inches for bonding topsoil with subsoil.
   4. On sloped areas, work topsoil into subsoil to blend so as to eliminate any semblance of slip-planing between two soils; but leave a sufficient cover of topsoil to ensure seed germination. Perform blending of soils by ridging or serrating subsoil on slopes.
   5. Place topsoil as needed for dressing-up minor depressions due to settling and erosion and to eliminate any other minor irregularities.

B. Finished Elevations And Lines: Grade topsoiled areas of site to within a tolerance of plus or minus 1/10 of a foot of elevations and lines indicated and in accordance with following:
   1. Grade a uniform longitudinal fall in swales and other surface drainage areas to provide a drainage flow line that can easily be maintained and traversed with normal lawn maintenance equipment.
   2. Establish finish grade of topsoil 1/2 to 3/4 inch below top of abutting walks or paving to provide positive drainage.
   3. Do not finish grade topsoil to a depth less than 6 inches nor greater than 12 inches.
   4. Leave finish grade surfaces free of objectionable material larger than one inch in greatest dimension. Dispose of objectionable material in a legal disposal area off site.

C. Compaction: Compact finish grades as final operation using a light roller weighing not over 120 pounds per foot width of roller.

D. Tillage: Till finish graded soil over areas indicated for lawn regardless of type of lawn work performed. Use equipment and methods common to such work, and till soil to a 2 inch depth minimum.

E. Soil Supplement Addition: Soil supplements for lawn areas, as required according to Engineer approved laboratory test reports, may be incorporated into soil during tillage operations.

END OF SECTION

SECTION 02315

EXCAVATION AND FILL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Excavation, excavation drainage, backfill and compaction requirements for buildings and structures indicated on Drawings.

B. Related Sections:
   1. Shoring: Section 02255.
   2. Rough Grading: Section 02311.
   3. Erosion and Sediment Control: Section 02370.
   4. Cast-In-Place Concrete: Section 03300.

1.02 REFERENCES

A. American Society For Testing and Materials:
   1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft.-lbf/ft.3).
   2. ASTM D1556, Density of Soil In Place By Sand Cone Method.
   3. ASTM D2167, Density of Soil In Place By Rubber-Balloon Method.
   4. ASTM D2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. Kentucky Transportation Cabinet (KYTC):
   1. Standard Specifications for Road and Bridge Construction:
      a. Section 805, Coarse Aggregates.

1.03 DEFINITIONS

A. Unclassified Excavation: Material removal of any kind in excavation, including Rock Excavation.

B. Subgrade: Prepared earth surfaces where on or over additional materials are placed or work is performed.

1.04 SUBMITTALS

A. On site and Borrow Backfill Materials: Submit for approval complete sieve analysis, compaction density, liquid limit and plastic limit test reports for on site and borrow excavated material desired to be used for backfill. Test in accordance with specified Referenced Standards. For disapproved material, either submit for approval above data for new borrow material, or procedures and materials proposed to render material suitable for use.

B. Aggregate: Submit samples and lab tests to Engineer for approval as specified below in Quality Assurance.

C. Blasting Plan:
   1. Submit data concerning proposed blasting operations to Engineer, and utility owners if required.

D. Testing Agency: Submit name and qualifications of Testing Agency performing seismographic tests to Engineer for approval prior to proceeding with blasting operations.

1.05 QUALITY ASSURANCE

A. Quality Control:
   1. Laboratory Tests: Aggregate materials under Part 2 - Products require advance examination or testing according to methods referenced, or as required by Engineer.
      a. Arrange for testing laboratory to furnish Engineer test result reports in triplicate. Test reports are considered as sufficient evidence of acceptance or rejection of materials represented.
      b. Conduct aggregate quality tests in accordance with requirements of appropriate Referenced Standard.
      c. Engineer reserves right to accept aggregate materials based on certification from supplier that aggregate originates from a source approved by the Kentucky Department of Highways and that aggregate complies with specified Kentucky Department of Highway requirements.
   2. Soil test samples to be approved by Engineer.

1.06 PROJECT CONDITIONS

A. Classification of Excavated Materials: No consideration will be given to nature of materials encountered in structural excavating operations. Therefore, as unclassified excavation, no additional payment will be made for difficulties occurring in excavating and handling of materials.

B. Environmental Requirements:
   1. As specified previously in Section 02311 and following additional requirements.
   2. Accommodation of Drainage: Maintain sewers, drains and ditches free of debris for surface drainage. No damming or ponding of water in gutters or other waterways permitted. Do not direct flow of water across or over pavements except through approved pipes or properly constructed troughs. Provide pipes or troughs of sizes and lengths required. Control grading in vicinity of excavations so ground surface is properly pitched to prevent water running into excavated areas.
   3. Pumping: Keep excavations free from water. Build dams and other devices necessary for this purpose, including lowering water table below excavation bottom by deep wells, well points and pumping. Provide and operate pumps of

sufficient capacity for dewatering excavations. Dispose of water removed from excavations in a manner not to cause injury to public health, public or private property, work of other trades or contractors, portions of work completed or in progress, or produce an impediment to highway, road, lane or street usage by public. No additional payment will be made for pumping or other difficulties encountered due to water.

4. Control groundwater and surface water during construction to maintain soil stability. Maintain water table elevation sufficiently below excavation levels so that slopes remain stable and bottoms of excavations do not become loosened by water flow. If foundation material looses strength due to improper dewatering techniques, overexcavate material and replace with Structural Foundation Backfill at no additional expense.
5. Perform soil erosion control work in accordance with requirements of Section 02370

C. Explosives and Blasting: Use and store explosives in accordance with requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees. No blasting permitted within 200 feet of existing water transmission mains, piping, and conduits. Additionally comply with following:
   1. Assume sole responsibility for injury to persons or property as a result of explosives and blasting.
   2. Schedule blasting in proximity of proposed new concrete work prior to placement of concrete.
   3. Notify utility owners having structures or other installations above or below ground in proximity to site of work prior to use of explosives. Give notice sufficiently in advance to enable utility owners to take steps necessary to protect their property from injury. Notifying utility owners does not relieve sole responsibility of damage resulting from use of explosives.
   4. Provide competent, licensed blaster to supervise blasting.
   5. Cease blasting operations when adjacent street paving is damaged. Repair damaged street paving.
   6. Employ an independent testing laboratory, acceptable to Engineer, to conduct seismographic tests in conjunction with blasting operations. Tests will be made to establish acceptable blast patterns and procedures, and as often as Engineer deems necessary.
   7. Prior to starting work, furnish Engineer data concerning proposed blasting operations. Include location, depth, and area of blast; diameter, spacing, depth, pattern, and inclination of blast holes; type, strength, quantity, column load, and distribution of explosives to be used per hole, per delay, and per blast; sequence and pattern of delays; and description and purpose of special methods to be adopted. Engineer reserves right to limit maximum size of explosive charge.
   8. Engineer's acceptance of blasting data and techniques does not relieve responsibility to exercise proper supervision and field judgment and to produce specified results.
   9. Blasting is permitted only after proper precautions have been taken for protection of persons, work and property. Control fly rock and material to prevent damage to persons or structures. When directed by Engineer, use blasting mats in areas

where overburden has been removed prior to blasting. Provide a positive means of dust control with equipment used for drilling of holes, subject to Engineer's approval.

10. Before blasting within 50 feet of cured concrete, submit and obtain approval of a plan showing relative positions of concrete, area to be blasted and blasting technique to be employed.
11. Perform blasting no closer than 25 feet from existing utilities, transverse crossings and parallel installations, unless utility company relieves this requirement. Before blasting within 150 feet of cured concrete, submit and obtain approval of a plan showing relative positions of concrete, area to be blasted, and blasting technique to be employed. Right is reserved by utility company not to allow blasting in trench adjacent to utility.
12. Use controlled blasting techniques. Modify blasting round as necessary to achieve best obtainable results and to keep air blast over pressure, vibrations and noise within limits specified. Exercise care in drilling and blasting operations to minimize overbreak and blast damage of adjacent unexcavated ground. Assume responsibility to produce a satisfactory excavated surface by determining proper relationships of factors of burden, spacing, depth of charge, quantity, and type of explosive, hole size and delay pattern, and other necessary considerations to achieve required results.
13. Perform blasting operations during normal working hours 7 am to 6 pm prevailing time. In event of an emergency, for example a thunderstorm, prevents a blast from being made before 6 pm, and holes are loaded, set blast off as soon as safety allows. In event blasting is found necessary during restricted hours, inform Owner and local residents, within hearing and vibration range, prior to firing. In addition, report in writing following day to Engineer, conditions requiring blasting during restricted hours. Impact or impulsive noise from blasting operations is not to exceed 130 dB peak sound pressure level measured at nearest structure or property line. Do not leave blasting materials in hole for extended periods of time.
14. Notify residents within hearing and vibration range, on morning of blasting as well as 72 hours in advance.
15. Store explosives on site only during blasting hours specified in preceding paragraph. Truck explosives to site at start of each workday from a magazine located remote from populated areas. Return surplus explosives to magazine at close of each workday. Locations of magazines on site and parking for explosives trucks will be determined by Engineer.
16. Monitor vibrations by measuring Peak Particle Velocity (PPV) in vicinity of blast at locations approved by Engineer. Provide experienced personnel to operate instrumentation used to monitor air blast overpressure and PPV. Arrange to have an experienced vibrations engineer available to review seismograph and instrumentation calibration data, and to recommend blasting techniques on Project. Data from measurements will be used in controlling blasting operations. PPV, as measured on or at structures in vicinity of blasting operations, is not to exceed 2 inches per second. Limitations on PPV do not relieve responsibility in ensuring integrity and safety of adjacent structures. PPV is defined as maximum

of 3 velocity components of a vibration measured at any point in 3 mutually perpendicular directions by a seismograph approved by Engineer, capable of producing a permanent record and capable of internal dynamic calibration. Record air blast overpressure with a peak impact recording instrument having linear frequency response.

17. Furnish, install, and operate at site, an approved thunderstorm monitor and automatic lightning warning device. Make adequate provisions for transmitting alarms from device to locations where electric blasting or preparation for electric blasting is in progress. Locate and install system according to manufacturer's recommendations. Employ qualified personnel to operate and periodically test entire monitoring and alarm system for satisfactory operation, and promptly correct discovered defects. Provide for repair or replacement of facilities damaged by blasting operations at no cost to Owner.

D. Responsibility For Condition Of Excavation: Assume responsibility for condition and results of excavations. Remove slides and cave-ins without extra compensation at whatever time and under whatever circumstances they occur.

E. Protection:
   1. At no additional expense, sustain in places, and protect from direct or indirect injury, pipes, tracks, walls, buildings, and other structures or property in vicinity of work, whether above or below ground, or that may appear in or adjacent to excavation. Keep a sufficient quantity of timber and plank, chains, ropes, and other material and equipment, on site for use as necessary for sheeting excavations and for sustaining or supporting structures that are uncovered, undermined, endangered, threatened, or weakened.
      a. Perform sheeting and shoring in accordance with requirements of Section 02255.
   2. Adequately support pipes and underground conduits exposed as a result of operations. Provide adequate support along entire exposed length by timber or planking, installed in a manner that anchorage of supporting members is not disturbed or weakened during backfilling operation. Carefully ram and tamp specified backfill materials under and around supports and leave in place as a guard against breakage of supported structure due to backfill settlement. No additional payment will be made for material left in place nor for labor of installing and maintaining supports.
   3. Assume risks attending presence or proximity of pipes, poles, power lines or wires, tracks, walls, buildings, and other structures and property, of every kind and description, in or over excavation, or in vicinity of work, whether above or below ground surface. Assume responsibility for damages and expenses for direct or indirect injury, caused by work, to persons or property by reason of them or by reason of injury to them whether structures are or are not indicated on Drawings.
   4. Where necessary, in order to keep one side of street or roadway free from obstruction or to keep material piled alongside excavation from falling on private property outside Rights-of-Way, place safe and suitable fence alongside excavation.

5. Engineer reserves right under above conditions to stop excavation or other part of work, and to require Contractor to complete structure and backfilling up to a point as Engineer, without assuming responsibility for safety to persons or property may require before proceeding further with excavation; and Contractor is not entitled to demand or to receive allowance or compensation, other than an extension of Contract time for as many days as Engineer may determine that work was delayed by stoppage.

F. Removal of Obstructions:
   1. Should pipe, conduit, pole, or other structures, above or below ground be in a position in opinion of Engineer, to require its removal, realignment, or change due to work to be done under Contract, work of removal, realignment, or change will be done as extra work, or will be done by Owner of obstructions, without cost to Contractor; but Contractor is required to uncover and sustain structures, at no additional expense, before removal and before and after realignment or change as constituting part of Contract; and no claim for damage or extra compensation on account of presence of structure, or on account of delay in removal or rearrangement of structure.
   2. Without extra compensation, break through and reconstruct if necessary, invert or arch of sewers, culverts, or conduits encountered if in a position, in judgment of Engineer, as not to require its removal, realignment, or complete reconstruction.
   3. Do not interfere with persons, firms or corporations or with Owner, in protecting, removing, changing, or replacing their pipes, conduits, poles, or other structures; but allow taking measures necessary or advisable under circumstances, without relieving responsibilities of Contract.
   4. Do not cut down trees in Rights-of-Way except by authorization of Engineer. No claim for extra compensation allowed if required to excavate by hand, or tunnel, in vicinity of trees ordered left standing. Carefully remove, protect and replant or replace shrubbery interfering with construction without additional cost to Owner.

G. Borrow Excavation: Where required quantity of backfill exceeds quantity of suitable material excavated within limits of Project site and Rights-of-Way, obtain sufficient material to complete backfill at no additional cost to Owner. If borrow excavation is needed, notify Engineer sufficiently in advance of borrow excavation requirements to permit Engineer to verify need for borrow excavation and to view proposed borrow pit and determine suitability of material to be provided. Borrow excavation from outside sources is subject to approval of Engineer. Obtain written consent before use of borrow excavation from outside sources.

H. Excess Materials: No right of property in materials is granted Contractor of excavated materials prior to backfilling. This provision does not relieve responsibility to remove and dispose of surplus excavated material. Obtain written consent and any necessary permits and approvals before disposing of excess materials at an off-site location.

PART 2 PRODUCTS

2.01 MATERIALS

A. Select Compacted Fill: As specified in Section 02311.

B. Structural Aggregate Backfill: Crushed Stone Base conforming to KYTC Section 805.

C. Drain Aggregate: No. 57 Aggregate conforming to KYTC Section 805. Drawings identify specific use of each aggregate.

D. Structural Foundation Backfill:
   1. Class B Concrete: As specified in Section 03300.

PART 3 EXECUTION

3.01 PERFORMANCE

A. Excavation:
   1. General:
      a. Perform excavation using machinery, except that hand excavation is required where necessary to protect existing structures, buried utilities or private or public properties. No additional compensation will be paid for hand excavation instead of machine excavation as may be necessary.
      b. Perform excavation of every description and of whatever substances encountered to lines and grades or depths indicated by Drawings and as specified in this Section.
      c. Where work space is limited, remove excavated material from limited area and replace material after structure has been installed. No additional compensation will be made for removal and replacement.

B. Excavation Below Subgrade:
   1. Do not excavate below depths indicated on Drawings or depths required by Engineer.
   2. Excavation below depths indicated on Drawings or as required by Engineer, through fault of Contractor, will be restored to indicated or required depths with Structural Foundation Backfill at no additional expense.
   3. Remove rock below subgrade that is shattered due to excessive drilling or blasting and unfit for foundations. Fill to subgrade with Structural Foundation Backfill those areas where shattered rock has been removed. Perform backfilling to Engineers approval and at no additional expense to Owner.

C. Borrow Excavation: Perform excavation of borrow material in a manner satisfactory to Engineer. Strip borrow pits of brush, trees, roots, grass and other vegetation prior to removal of material for use in backfill. During excavation operation, grade borrow area to ensure free drainage of water from area. Place and maintain erosion control devices. After completion of excavation, grade excavated area, including side slopes,

to drain and present a uniformly trim appearance merging into surrounding terrain. After borrowing operations are completed, regrade area, if necessary, to prevent erosion.

D. Select Compacted Fill:
   1. General:
      a. Use Select Compacted Fill in that area within a vertical plane 5 feet beyond neat lines of structure, unless directed otherwise by Engineer or Drawings.
      b. Perform backfilling using machinery, except that hand backfilling may be required where necessary to prevent displacing walls, foundations or buried utilities or damage to them. No additional compensation will be paid where backfilling by hand is required.
      c. After completion of footings and walls and removal of forms and prior to backfilling, clean excavation free of trash and debris.
      d. Where a structure is placed on an embankment, bring embankment up to 2 feet above planned elevations of foundation and footing prior to excavation for structure.
   2. Backfill and Compaction: Place Select Compacted Fill in horizontal lifts not exceeding 6 inches in depth, moistened if required and compact to a density of not less than 97 percent of maximum dry weight density with in-place moisture content within 2 percentage points of optimum moisture content as determined in accordance with ASTM D698.
      a. Field compaction density may be determined by Sand Cone Method ASTM D1556, Rubber Balloon Method ASTM D2167, Nuclear Method ASTM D2922 or other acceptable method, as approved by Engineer.
      b. Make a minimum of 2 field moisture-density determinations for each lift in accordance with approved method.
      c. When material is too coarse to satisfactorily use this method, compaction will be determined by Engineer based on nonmovement of material under compaction equipment.
      d. Moisture content of Select Compacted Fill at time of compaction is not to be more than 2 percentage points above optimum moisture content per ASTM D698, except that Select Compacted Fill that displays pronounced elasticity or deformation under compaction or construction equipment should not have a moisture content greater than optimum moisture content.

E. Structural Foundation Backfill:
   1. Class B Concrete: As specified in Section 03300.

F. Structural Aggregate Backfill:
   1. General:
      a. Place Structural Aggregate Backfill and compact as indicated on Drawings.
      b. Perform backfilling using machinery, except that hand backfilling may be required where necessary to prevent damaging or displacing walls, foundations or buried utilities. No additional compensation will be paid where backfilling by hand is required.

c. After completion of footings and walls and removal of forms and prior to backfilling, clean excavation free of trash and debris.

2. Backfill and Compaction: Place structural aggregate backfill in horizontal layers not exceeding 8 inches in depth, moisten if required and compact using a vibratory steel roller to a density of not less than 98 percent of maximum dry weight density with in-place moisture content within 2 percentage points of optimum moisture content, as determined per ASTM D698.
   a. Field compaction density may be determined by Sand Cone Method ASTM D1556, Rubber Balloon Method ASTM D2167, Nuclear Method ASTM D2922 or other acceptable method, as approved by Engineer.
   b. Make a minimum of 2 field moisture-density determinations for each lift in accordance with approved method.
   c. Compaction by hand not accepted.

G. Drain Aggregate: Place Drain Aggregate in 8 inch layers and thoroughly compact each layer with a vibratory compactor to Engineers approval.

H. Cleanup:
   1. Remove and dispose of excess excavated material that cannot be used on Project off site in a legal manner at no additional expense to Owner.

END OF SECTION

SECTION 02324

TRENCHING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Excavating, backfilling, and compacting trenches for pipelines and inline structures, within limits specified or indicated on Drawings.

B. Related Sections:
   1. Shoring: Section 02255.
   2. Erosion and Sediment Control: Section 02370.
   3. Cast-In-Place Concrete: Section 03300.

1.02 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft.-lbf/ft.3).
   2. ASTM D2922, Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

B. Kentucky Transportation Cabinet (KYTC):
   1. Standard Specifications for Road and Bridge Construction:
      a. Section 805, Coarse Aggregates.

1.03 DEFINITIONS

A. Unclassified Excavation: Material removal of any kind in excavation, including Rock Excavation.

B. Unclassified Excavation Below Subgrade: As specified for Unclassified Excavation except performed below subgrade.

C. Subgrade: Trench bottom prepared as specified to receive Class A Bedding, Concrete Cradle or Concrete Encasement, or excavation bottom prepared to receive pipeline structures.

1.04 SUBMITTALS

A. Test Reports:
   1. Submit testing laboratory aggregate test reports based on requirements stated in Quality Control.
   2. Compaction density test reports based on method of density determination as specified in Reference Standards and method approved by Engineer.

B. Certificates: Submit certificate from aggregate supplier based on requirements stated in Quality Control, when requested by Engineer.

C. Blasting Plan:
   1. Submit data concerning proposed blasting operations to Engineer, and utility owners if required.

D. Testing Agency: Submit name and qualifications of Testing Agency performing seismographic tests to Engineer for approval prior to proceeding with blasting operations.

1.05 QUALITY ASSURANCE

A. Quality Control:
   1. Laboratory Tests: Aggregate materials under Part 2 - Products require advance examination or testing according to methods referenced, or as required by Engineer.
      a. Arrange for testing laboratory to furnish Engineer test result reports in triplicate. Test reports are considered sufficient evidence of acceptance or rejection of materials represented.
      b. Conduct aggregate quality tests in accordance with requirements of appropriate Referenced Standard.
      c. Engineer reserves right to accept aggregate materials based on certification from supplier that aggregate originates from a source approved by Kentucky Department of Highways and that aggregate complies with specified Kentucky Department of Highway requirements.

1.06 PROJECT CONDITIONS

A. General Requirements: Excavate and backfill trenches necessary for completing work of this Contract. Excavate and backfill trenches by machinery or by hand, however, Engineer is empowered, if necessity exists, to direct that hand excavation and backfilling be employed. Perform excavation of whatever substances encountered, to grades and depths indicated on Drawings, as specified, or as directed by Engineer. Remove and waste excavated material not required for backfill.

B. Environmental Requirements:
   1. Do not perform trenching, backfilling or compacting when weather conditions or condition of materials will prevent satisfactory work, in opinion of Engineer.
   2. Do not use frozen materials as backfill or wet materials containing moisture in excess of quantity necessary for satisfactory compaction.
   3. Prior to use, moisten dry backfill material not having sufficient moisture to obtain satisfactory placement or compaction.
   4. Plan work to provide adequate protection during storms with provisions available constantly for preventing flood damage. Protect installed piping and other work against damage from uplift due to high ground water levels.

5. Accommodation of Drainage: Keep gutters, sewers, drains and ditches open constantly for surface drainage. No damming, ponding, water in gutters, or other waterways permitted, except where stream crossings are necessary and then only to extent Engineer considers necessary. Do not direct water flows across or over pavements except through approved pipes or properly constructed troughs. When required, provide pipes or troughs of sizes and lengths required at no expense to Owner. Perform grading in vicinity of trenches so that ground surface is properly pitched to prevent water running into trenches.
6. Pumping: Keep excavations free from water during performance of work at no expense to Owner. Build dams and other devices necessary for this purpose, and provide and operate pumps of sufficient capacity for dewatering excavations. Provide for disposal of water removed from excavations in a manner not to cause injury to public health, public or private property, work of others, portions of work completed or in progress, or produce an impediment to street, road and highway usage.
7. When necessary to haul soft or wet soil material over roadways, use suitably tight vehicles to prevent spillage. Clear away spillage of materials on roadways caused by hauling.
8. Provide effective dust control by sprinkling water, use of calcium chloride or other method approved by Engineer. Employ dust control when, where and in a manner required by Engineer.
9. Comply with Section 02370, Erosion and Sediment Control.

C. Explosives and Blasting: Use and store explosives in accordance with requirements of Federal, State and local laws, rules, regulations, precautions, orders and decrees. Additionally comply with following:
   1. Do not use methods of blasting that result in breakage beyond trenching areas or is dangerous to public or destructive to property.
   2. Assume sole responsibility for injury to persons or property as a result of explosives and blasting.
   3. Schedule blasting in proximity of proposed new concrete work prior to placement of concrete.
   4. Notify utility owners having structures or other installations above or below ground in proximity to trenching work prior to use of explosives. Give notice sufficiently in advance to enable utility owners to take steps necessary to protect their property from injury. Notifying utility owners does not relieve sole responsibility of damage resulting from use of explosives.
   5. Provide competent, licensed blaster to supervise blasting.
   6. Cease blasting operations when street paving adjacent to trench is damaged. Repair damaged street paving.
   7. Employ an independent testing laboratory, acceptable to Engineer, to conduct seismographic tests in conjunction with blasting operations. Tests will be made to establish acceptable blast patterns and procedures, and as often as Engineer deems necessary.
   8. Prior to starting work, furnish Engineer data concerning proposed blasting operations. Include location, depth, and area of blast; diameter, spacing, depth, pattern, and inclination of blast holes; type, strength, quantity, column load, and

distribution of explosives to be used per hole, per delay, and per blast; sequence and pattern of delays; and description and purpose of special methods to be adopted. Engineer reserves right to limit maximum size of explosive charge.

9. Engineer's acceptance of blasting data and techniques does not relieve responsibility to exercise proper supervision and field judgment and to produce specified results.
10. Blasting is permitted only after proper precautions have been taken for protection of persons, work and property. Control fly rock and material to prevent damage to persons or structures. When directed by Engineer, use blasting mats in areas where overburden has been removed prior to blasting. Provide a positive means of dust control with equipment used for drilling of holes, subject to Engineer's approval.
11. Perform blasting no closer than 25 feet from existing utilities, transverse crossings and parallel installations, unless utility company relieves this requirement. Before blasting within 150 feet of cured concrete, submit and obtain approval of a plan showing relative positions of concrete, area to be blasted, and blasting technique to be employed. Right is reserved by utility company not to allow blasting in trench adjacent to utility.
12. Use controlled blasting techniques. Modify blasting round as necessary to achieve best obtainable results and to keep air blast over pressure, vibrations and noise within limits specified. Exercise care in drilling and blasting operations to minimize overbreak and blast damage of adjacent unexcavated ground. Assume responsibility to produce a satisfactory excavated surface by determining proper relationships of factors of burden, spacing, depth of charge, quantity, and type of explosive, hole size and delay pattern, and other necessary considerations to achieve required results.
13. Perform blasting operations during normal working hours 7 am to 6 pm prevailing time. In event of an emergency, for example a thunderstorm, prevents a blast from being made before 6 pm, and holes are loaded, set blast off as soon as safety allows. In event blasting is found necessary during restricted hours, inform Owner and local residents, within hearing and vibration range, prior to firing. In addition, report in writing following day to Engineer, conditions requiring blasting during restricted hours. Impact or impulsive noise from blasting operations is not to exceed 130 dB peak sound pressure level measured at nearest structure or property line. Do not leave blasting materials in hole for extended periods of time.
14. Notify residents within hearing and vibration range, on morning of blasting as well as 72 hours in advance.
15. Store explosives on site only during blasting hours specified in preceding paragraph. Truck explosives to site at start of each work day from a magazine located remote from populated areas. Return surplus explosives to magazine at close of each work day. Locations of magazines on site and parking for explosives trucks will be determined by Engineer.
16. Monitor vibrations by measuring Peak Particle Velocity (PPV) in vicinity of blast at locations approved by Engineer. Provide experienced personnel to operate instrumentation used to monitor air blast overpressure and PPV. Arrange to have

an experienced vibrations engineer available to review seismograph and instrumentation calibration data, and to recommend blasting techniques on Project. Data from measurements will be used in controlling blasting operations. PPV, as measured on or at structures in vicinity of blasting operations, is not to exceed two inches per second. Limitations on PPV do not relieve responsibility in ensuring integrity and safety of adjacent structures. PPV is defined as maximum of three velocity components of a vibration measured at any point in three mutually perpendicular directions by a seismograph approved by Engineer, capable of producing a permanent record and capable of internal dynamic calibration. Record air blast overpressure with a peak impact recording instrument having linear frequency response.

17. Furnish, install, and operate at site, an approved thunderstorm monitor and automatic lightning warning device. Make adequate provisions for transmitting alarms from device to locations where electric blasting or preparation for electric blasting is in progress. Locate and install system according to manufacturer's recommendations. Employ qualified personnel to operate and periodically test entire monitoring and alarm system for satisfactory operation, and promptly correct discovered defects. Provide for repair or replacement of facilities damaged by blasting operations at no cost to Owner.

D. Removal of Rock by Means Other Than Blasting: Where removal of rock by means other than blasting is required, in accordance with requirements of State and local laws, rules and regulations, and utility owner requirements, remove by use of mechanical surface impact equipment, or by drilling and hydraulic rock splitting equipment, or by other methods.

E. Responsibility for Condition of Excavation: Assume responsibility for condition and results of excavation. Remove slides and cave ins at whatever time and under whatever circumstance they occur.

F. Protection: Assume risks attending presence or proximity of overhead or underground public utility and private lines, pipes, conduits and support work, existing structures and property of whatever nature. Assume responsibility for damages and expenses for direct or indirect injury to structures or to person or property by reason of them or by reason of injury to them; whether structures are or are not shown on Drawings, by work of this Contract.

1. Outside Rights-of-Way: Take necessary precautions to protect trees, shrubs, lawns and other landscaping from damage. Restitution work for damages rests solely with Contractor and at no expense to Owner.
2. Pipe Supports: Adequately support underground pipes or conduits exposed as a result of excavations. Provide adequate support along entire exposed length by timber or planking. Install supports in a manner that backfilling may be performed without dislodging pipes or conduits. Place and carefully compact required Select Backfill or Aggregate Backfill around supports, and leave in place as a guard against breakage due to backfill settlement. No additional payment will be made for support material left in place nor for labor of installing and maintaining supports.

G. Structure Supports: Where trenching past buildings or structures that by their construction or position might exert detrimental pressure upon trench, right is reserved by Engineer to require that buildings or structures, be underpinned or supported and protected, or special sheeting be driven, or that short lengths of trench be opened at one time.

H. Removal of Obstructions:
   1. Remove, realign or change direction of above or below ground utilities and appurtenant supports, if required in opinion of Engineer. Perform as extra work unless performed by owner of obstruction without cost to Contractor. However, uncover and sustain obstruction at no additional cost prior to final disposition of obstruction. No claims for damage or extra compensation due to presence of obstructions or delay in removal or rearrangement of obstructions will be made. Additional precautions concerning obstructions as follows:
      a. Do not interfere with persons, firms, corporations or utilities employing protective measures, removing, changing or replacing their property or structures, but allow taking measures necessary or advisable under circumstances, without relieving responsibilities of Contract.
      b. Without extra compensation, break through and reconstruct if necessary, invert or arch of sewers, culverts or conduits encountered if structure is in a position, in judgment of Engineer, as not to require its removal, realignment or complete reconstruction.

I. Advance Trenching: Where existing utilities or other suspected underground obstructions are within close proximity of proposed pipelines, uncover and verify exact location of obstructions far enough in advance of pipelaying to allow changes in pipe alignment or grade required to bypass obstructions and to avoid removing sections of pipe already installed. If sections of installed pipe require removal and reinstallation as a result of not verifying utilities or other underground obstructions far enough in advance, remove and reinstall pipe at no additional cost.

J. Excess Materials: No right of property in materials is granted for excavated materials prior to backfilling. This provision does not relieve responsibility to remove and dispose of surplus excavated materials. Obtain written consent and any necessary permits and approvals before disposing of excess materials at an off-site location.

K. Borrow Excavation: Where required quantity of backfill exceeds quantity of suitable material excavated within limits of Project site and Rights-of-Way, obtain sufficient material to complete backfill at no additional cost to Owner. If borrow excavation is needed, notify Engineer sufficiently in advance of borrow excavation requirements to permit Engineer to verify need for borrow excavation and to view proposed borrow pit and determine suitability of material to be provided. Borrow excavation from outside sources is subject to approval of Engineer. Obtain written consent and any necessary permits and approvals before use of borrow excavation from outside sources.

L. Change of Trench Location or Depth:
   1. Should Engineer require a change in location of a trench from that indicated on Drawings due to presence of an obstruction, or from other cause, and change in location increases or decreases quantity of excavation, then an adjustment will be made in the lump sum price bid in accordance with Article 10 of the General Conditions.

M. Accommodation of Traffic: Do not obstruct streets, roads and highways. Unless Municipality or Governing Agency authorizes in writing complete closing of street, road or highway, employ necessary measures at no expense to Owner to keep street, road or highway open and safe for traffic. Maintain a straight and continuous passageway on sidewalks and over crosswalks, at least three feet wide and free from obstructions. Do Not Obstruct Fire Hydrants.

N. Classification of Excavated Materials: No consideration will be given to nature of materials encountered in trenching operations. Therefore, as unclassified trenching, no additional payment will be made for difficulties occurring in excavating and handling of materials.

PART 2 PRODUCTS

2.01 MATERIAL

A. General: All materials to be free of topsoil, plant life, lumber, metal, refuse, coal waste, slag and cinders

B. Approved Backfill: On site excavated soil or soil-rock mixed materials free of rocks or similar hard objects larger than six inches in any dimension. Rocks or similar hard objects are not to represent more than 20 percent of backfill by volume.

C. Select Backfill: On site excavated material free of rocks or similar hard objects larger than one inch in any dimension.

D. Aggregate Backfill: Crushed Stone Base conforming to KYTC Section 805.

E. Pipe Bedding: Size No. 8 coarse aggregate conforming to KYTC Section 805.

F. Concrete Cradle and Encasement: Per requirements of Cast-In-Place Concrete - Section 03300 and of following Class:
   1. Class B: 3000 psi.

G. Underground Warning Tapes: Underground Warning tapes to be marked with a continuous two line message. Upper line to have in bold lettering: CAUTION, lower line to read BURIED WATER LINE BELOW. Printing to be black on 6 inch wide, 0.004 inch thick blue polyethylene film conforming to latest APWA and AASHTO specifications. Tape to be Catalog Style No. 37244 as supplied by Seton Identification

Products or approved equal. Bury tape over centerline of pipe approximately 1.5 feet below finished grade.

PART 3 EXECUTION

3.01 PERFORMANCE

A. Perform sheeting and shoring in accordance with requirements of Section 02255.

B. Perform soil erosion control work in accordance with requirements of Section 02370.

C. Excavating: Perform excavation and backfilling using machinery except that hand excavation and backfilling may be required where necessary to protect existing structures, utilities, private or public properties. No additional compensation will be paid for hand excavation and backfilling instead of machine excavation and backfilling as may be necessary.
   1. Remove surface materials of whatever nature, including pavement and topsoil, over line of trenches and other excavations and properly separate and store removed materials as suitable for use in backfilling or other purposes.
   2. Remove subsurface materials of whatever nature, including rock, masonry and cementitious materials, down to subgrade elevation. Properly separate and store removed subsurface materials as suitable for use in backfilling.
   3. Remove rock to subgrade at least 25 feet in advance of pipe laying.
   4. Remove rock below subgrade if shattered due to excessive drilling and blasting, and in opinion of Engineer it is unfit for foundations. Backfill to subgrade with Class B Concrete per requirements of Cast-In-Place Concrete - Section 03300, Size No. 8 coarse aggregate conforming to requirements for Pipe Bedding, or other material acceptable to Engineer. No separate or additional payment will be made for removal and backfill due to excessive drilling and blasting.
   5. Excavate rock in miscellaneous excavations to extent required by Engineer.
   6. When rock is encountered in excavations where blank connections are to be left for future extensions of waterlines, remove rock for a distance of not less than ten feet from blank connection in direction of future extension. Excavate trench to specified width, depth and length.
   7. Remove and waste or otherwise dispose of excavated materials not required for backfill at no expense to Owner.

D. Trench Width and Depth: For full depth of trench, maximum trench pay width is a vertical plane as specified in Table A. If sheeting is required, following Table A dimensions apply to the inside face of sheeting.

TABLE A	
Diameter of Pipe	Maximum Trench Width (Outside Diameter of Pipe at Barrel Plus)
3 through 36 inches	24 inches
42 through 72 inches	30 inches
Larger than 72 inches	36 inches

1. Depth: Excavate below planned bottom of pipe, 4 inches in earth and 8 inches in rock.
2. No additional compensation will be paid for excavation beyond trench widths indicated in Table 'A' unless approved in writing by Engineer.
3. Excavate rock for manhole, chamber, catch basin or other structure installations 1 foot outside exterior lines of structure walls and to a depth of outside bottom.

E. When unsuitable material is found below subgrade, as determined by Engineer, remove material to a depth determined by Engineer, and provide Class A Bedding compacted in 4 inch layers.

F. Length of Open Trench: Engineer has right to limit quantity of trench opened in advance of pipe laying and quantity of pipe laid in advance of backfilling, but in no case are these quantities to exceed 300 feet and 100 feet respectively. Complete trench excavation at least twenty five feet in advance of pipe laying and keep trenches free from obstructions, except that at end of a work day or at discontinuance of work, pipe laying may be completed to within five feet of end of open trench. Additional open trench limitations as follows:
1. Engineer is empowered to require trench backfilling over completed pipe lines at any time if in his judgment it is necessary. No claim for extra compensation will be allowed for trench refilling even though work stopped elsewhere as a result.
2. If trenching work is stopped for any reason, except as required by Engineer, and excavation is left open for an unreasonable period in advance of construction in opinion of Engineer, Engineer may order trench refilling at no additional expense and not allow trench reopening until ready for actual use.

G. Excavated Material Storage:
1. In streets, roads, and highways, or in other locations where working space is limited, remove excavated materials from first 100 feet of opening as soon as its excavated, when required by Engineer. Store and return excavated materials for

backfilling when required, at no expense to Owner. In no case cast excavated material beyond curb or Right-of-Way lines or on sidewalks or lawns.

2. Where more material is excavated from trenches than can be backfilled or stored on street or within Rights-of-Way limits, leaving space for traffic and drainage, remove and store excess material. Return excess material for backfilling when required, at no expense to Owner.

H. Subgrade Preparation: Provide Pipe Bedding in trenches as pipe foundations. Depth of Bedding is indicated on Drawings. In lieu of Pipe Bedding, provide concrete encasement or concrete cradle or other type of bedding as indicated on Drawings or required by Engineer. If maximum trench widths specified in Table A are exceeded, provide concrete cradle or concrete encasement at no expense to Owner.

I. Backfilling: Perform trench backfilling and backfilling excavations for other in line structures by methods resulting in thorough compaction of backfill material without displacement of grade and alignment of pipeline and its appurtenances and minimum settlement of backfilled material. Displacement of pipeline and settlement of backfill will be considered evidence of improper workmanship or inclusion of unsuitable backfill materials, or both, and will require regrading and realigning pipeline and removing and recompacting settled material at no expense to Owner. Following pipe bedding, piping and inline structure installation, backfill trenches in following manner:

1. Areas to be Paved: Backfill trenches to a height at least one foot above top of outside barrel of pipe with Select Backfill material placed in four inch layers. Carefully place this backfill in a manner not to damage or disturb pipe. Backfill remainder of trench with Aggregate Backfill compacted in four inch layers to bottom of temporary or permanent paving. If vibratory compaction equipment is used, lifts may be 8 inches.
2. Unpaved Areas: Backfill trenches to a height at least one foot above top of outside barrel of pipe with Select Backfill material placed in four inch layers. If vibratory compaction equipment is used, lifts may be 8 inches. Carefully place this backfill in a manner not to damage or disturb pipe. Backfill remainder of trench with Approved Backfill compacted in eight inch layers to bottom of topsoil. Replace topsoil to approximate depth of existing, as final refill operation and crown to height required by Engineer. Maintain crowned surface as required by Engineer, during guarantee period.

J. Compacting: During course of backfilling and compacting work, Engineer may, at any location or depth of trench, require Contractor to perform tests to determine whether compaction operations are sufficient to meet specified requirements. Compact trench backfill as follows:

1. Solidly tamp each layer of required backfill around pipeline with proper tamping tools made specially for this purpose.
2. Thoroughly compact aggregate backfill with a vibratory compactor of type and size satisfactory to Engineer. Compacting of aggregate backfill by puddling or jetting is not permitted.
3. Use mechanical tampers to compact backfill materials in trench refill operations to produce a density at bottom of each layer of not less than 95 percent of

maximum density obtained at optimum moisture content as determined by ASTM D698. Perform field determinations of density, in accordance with ASTM D2922. Make a minimum of two field determinations for each lift of backfill for every 200 ft. length of trench.

4. From a point one foot above top of pipe to subgrade of paving (or below surface where paving is not required), compact backfill by tamping. Use of Hydra-Hammer for compacting backfill in trenches is prohibited.

K. Embankment Construction for Pipelines:
   1. Embankment Construction: Construct embankments in accordance with the following paragraphs:
      a. Embankment Foundation: Remove existing embankment foundation material when determined unsatisfactory by the Engineer. Refill such areas to original elevation in the same manner specified for formation of embankment.
         1) Scarify embankment foundation surface where embankment three feet or more in height is to be placed. Scarify or otherwise loosen embankment foundation surface to a depth of six inches where embankment less than three feet in height is to be placed.
         2) Existing embankment foundations having a slope steeper than four to one shall be plowed to provide embankment binding when required by the Engineer. On steeper slopes the Engineer may require the foundation to be cut into steps or berms.
         3) Fill existing natural depressions or such other depressions resulting from the site work to the level of adjacent ground elevation in the same manner specified for formation of embankment prior to starting initial embankment layer.
      b. Formation of Embankment: Use On-Site Backfill material placed in nine inch layers and each compacted separately using equipment meeting with Engineer's approval. Carry the whole embankment up evenly the required elevation without breaks or irregularities in material distribution or in the formation of layers. Trim embankment slopes and leave in a neat and acceptable condition.
         1) Add water to On-Site Backfill material which does not contain a sufficient amount of moisture to obtain the required compaction. On-Site Backfill material containing moisture in excess of the amount required to obtain the necessary compaction density may not, without written approval, be incorporated in the embankment until allowed to dry to a moisture content not greater than two percentage points above optimum for that particular material.
         2) When pipe is to be laid in fill, bring embankment height to at least two feet above the top of the pipe before the trench is excavated.
         3) Compact embankment material to a minimum final density of not less than 90 percent of the maximum dry weight density at its optimum moisture content.

L. Cleanup:
   1. Remove surplus excavated material, rubbish and other construction debris, and keep removed to a point not more than two hundred feet from head of open trench, unless otherwise authorized by Engineer.
   2. After trenches and other excavations are backfilled and work completed, remove surplus excavated materials, rubbish or other materials from work site. Dispose of materials off site in a lawful manner at no additional expense to Owner.
   3. Evenly spread and leave in neat, smooth condition excavated material disposed of lawfully on public property.
   4. Furnish and place topsoil, fertilize and seed grassed areas, within and outside Rights-of-Way affected by construction. Reseed and refertilize areas that fail to show a uniform stand of grass. Water, mow, rake, weed and otherwise maintain grass until final acceptance of Contract.
   5. Restore area covered by temporary and permanent Rights-of-Way to as near original conditions as is practical. Bring area up to original grade, place topsoil, seed, replant or replace shrubbery, repair or replace walks, driveways, fences and other improvements, damaged or removed.
   6. When repaving over trenches and other excavations is completed, sweep paved surfaces affected by work using hand or power sweepers, and if required by Engineer, flush with water to remove dust and small particles.
   7. In case Contractor fails or neglects to do so or makes unsatisfactory progress in doing so, within twenty four hours after receipt of a written notice from Engineer, Owner may remove surplus material and clear roadways, sidewalks and other places, and expense for work charged to Contractor and deducted from moneys due or to become due him under Contract.

M. Maintenance: Assume responsibility for injury or damage resulting from lack of trench maintenance during guarantee period. If trench surfaces are not satisfactorily maintained or repairs begun within seven days after written notice from Engineer, repairs may be made by Owner, and cost charged against Contractor.

END OF SECTION

SECTION 02336

ROADWAY EXCAVATION, BACKFILL, AND COMPACTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision for excavation, backfill and compaction required to prepare subgrade for access roads and sidewalks.

B. Related Sections:
   1. Rough Grading: Section 02311.
   2. Erosion and Sediment Control: Section 02370.
   3. Bases, Ballasts, Pavements, and Appurtenances: Section 02700.

1.02 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM D698; Standard Test Methods for Laboratory Compaction Characteristics of Soil using Standard Effort (12,400 ft.-lbf/ft.3).

1.03 DEFINITIONS

A. Roadway Subgrade: Prepared earth surfaces on or over which additional roadway materials are placed or work performed.

1.04 PROJECT CONDITIONS

A. As specified previously in Section 02311.

PART 2 PRODUCTS

2.01 MATERIALS

A. As specified previously in Section 02311.

PART 3 EXECUTION

3.01 PERFORMANCE

A. Perform soil erosion control work in accordance with requirements of Section 02370.

B. Roadway Excavation: Excavate or otherwise remove and satisfactorily dispose of materials located within limits indicated on Drawings.
   1. Excavate to roadway subgrade depths required, and cut drainage channels and waterways as detailed on Drawings.
   2. Remove rock encountered in roadway excavation to a depth six inches below finished subgrade elevations.

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3. Excavate subgrade material determined unsatisfactory in opinion of Engineer. Refill areas to required elevation with Backfill.

C. Roadway Grading: Shape subgrade of roadways, intersections, approaches, entrances and adjoining pedestrian walkways to no more than 0.10 foot above or below elevations indicated on Drawings.

D. Roadways Embankments: Construct embankments for roadways as specified previously in Section 02311 with exception that materials other than Backfill may be used. Till or other rock formations that can be readily incorporated in an 8 inch layer may be used. Construction requirements for roadway embankment containing rock are as follows:
   1. Break up till and other rock like materials formed by natural consolidation of mud, clay, silt and fine sand into a maximum size that can be readily placed and compacted in loose eight inch layers. Maximum percent of rock not to exceed 20 percent of total volume of embankment at any point.
   2. Place rock to form base of roadway embankments. Place in uniform loose layers not exceeding in depth approximate average size of larger rock, but not exceeding 8 inches deep.
   3. Smooth and level each layer adding Coarse Aggregate Material in sufficient quantity to supplement smaller rock pieces in filling voids and pockets.
   4. Form top 18 inches of roadway embankments with Backfill and construct as specified for formation of embankments other than those containing rock.
   5. Compact embankment material to a minimum final density of not less than 95 percent of maximum dry weight density at its optimum moisture content, as determined per ASTM D698.
   6. Provide Borrow Excavation materials required for embankment meeting requirements of Backfill. During excavation operation, keep borrow area graded to ensure free water drainage. Following completion of work in borrow area, grade area to present a uniformly trim appearance merging into surrounding terrain and to prevent serious erosion.

E. Compaction: Compact subgrade material to a minimum final density of not less than 95 percent of maximum dry weight density at its optimum moisture content. Perform finish rolling on roadway subgrade just prior to installation of aggregate base course.

F. Roadway Base Course Construction: Final subgrade preparation and roadway base course construction as specified in Section 02700.

3.02 FIELD QUALITY CONTROL

A. Surface Tolerance: Check finished subgrade surface for smoothness and elevation in accordance with following:
   1. Use an approved template shaped to conform to design requirement indicated on Drawings for checking crown and contour of roadways.
   2. Use an approved ten foot straightedge to check for longitudinal irregularities in subgrade.

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3. Use string lines for controlling finished elevation of roadway subgrade. Maintain lines until surface irregularities have been satisfactorily corrected.

B. Corrections: Correct surface irregularities exceeding previously specified limits by removing or adding material, followed by rolling until satisfactorily compacted.

C. Field Moisture-Density Tests: Conduct tests as previously specified under Section 02311.

END OF SECTION

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SECTION 02370

EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of the erosion and sediment control (E&S) measures for the earthwork activities as specified in various other Sections of the Project Manual.
   1. The E&S protection measures for the Project are presented in Narrative form on the Drawings and also illustrated in Details on the Drawings.

B. Related Sections:
   1. Finish Grading: Section 02312.

1.02 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM A 82; Specification for Cold-Drawn Steel Wire for Concrete Reinforcement.
   2. ASTM D3776, Standard Test Method for Mass Per Unit Area (Weight) of Woven Fabric.
   3. ASTM D4355, Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water.
   4. ASTM D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   5. ASTM D4533, Test Method for Trapezoid Tearing Strength of Geotextiles.
   6. .ASTM D4632, Standard Test Method for Breaking Load and Elongation of Geotextiles (Grab Method).
   7. ASTM D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   8. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
   9. ASTM D4884, Standard Test Method for Seam Strength of Sewn Geotextiles.

B. Kentucky Transportation Cabinet (KYTC):
   1. Standard Specifications for Road and Bridge Construction:
      a. Section 827.05, Mulch Materials.
      b. Section 827.06, Asphalt Materials For Mulch.
      c. Section 827.07, Erosion Control Blanket.
      d. Section 827.08, Temporary Silt Fence.
      e. Section 843, Geotextile Fabrics.

C. National Stone, Sand & Gravel Association (NSSGA)

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1.03 SUBMITTALS

A. Furnish certificates from manufacturers of following materials, certifying their products meet requirements of these Specifications. Submit material samples if requested by the Engineer.
   1. Matting/Geotextile for Erosion Control.
   2. Filter Fabric Fence.
   3. Aggregates.
   4. Seeding mixtures.
   5. Filter bag pumped sediment removal and inlet protection devices.

B. E&S Plan for Off-Site Spoil Area: If an off-site spoil area for excess materials is required, prepare and submit for approval a Contractor prepared E&S Plan for the off-site spoil area. Submit the plan to the appropriate county conservation district. The Contractor shall have an approved E&S Plan prior to the start of earthmoving activities.

C. Submit Erosion and Sedimentation Controls Contractor's Inspection Report as required under Project Conditions.

1.04 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Contractor is responsible for executing the form attached to the end of this Section and provide it to the Resident Project Representative on a regular basis as indicated on the form.

1.05 QUALITY ASSURANCE

A. Preconstruction Conference: Be prepared at preconstruction conference to submit for review, schedules and methods for accomplishing the approved soil erosion and sedimentation control plan. No work will be started until soil erosion and sedimentation control schedules, methods and materials have been submitted to the Engineer.

B. In case of repeated failure on part of Contractor to control erosion, pollution, or siltation, Owner reserves the right to employ outside assistance or to use own forces to provide necessary corrective measures. Such incurred direct costs plus related engineering costs will be charged to Contractor and appropriate deductions made from any moneys due or to become due him under Contract.

1.06 DELIVERY, STORAGE AND HANDLING

A. Delivery and Handling: Transport and handle Products, specified herein, in a manner recommended by the respective manufacturers of such, to prevent damage and defects.

B. Storage: Store Products in accordance with manufacturer's recommendations to prevent damage and contamination.

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PART 2 PRODUCTS

2.01 MATTING FOR EROSION CONTROL

A. Erosion Control Blanket: Conforming to KYTC Section 827.07.

2.02 EROSION CONTROL DEVICES

A. Wire: ASTM A82.

B. Filter Fabric Fence: Fabric conforming to KYTC Section 827.08.
   1. Standard Silt Fence.
   2. Reinforced Silt Fence:
   3. Super Silt Fence.

C. Rock Construction Entrance:
   1. Crushed Stone - AASHTO No. 1.
   2. Filter Cloth – Type III Fabric conforming to KYTC Section 843.

D. Pumped Water Sediment Removal Pond: Materials in accordance with Erosion and Sedimentation Control Plan Details and Notes.

E. Pumped Water Sediment Control Device (PWSCD):
   1. Nonwoven geotextile fabric sewn with double needle machine using high strength thread.
   2. Provide PWSCD with opening large enough to accomodate a 4 inch discharge hose with attached strap to tie off the hose preventing pumped water from escaping from PWSCD without being filtered.
   3. Properties:

PROPERTY	TEST METHOD	TEST RESULT
Weight	ASTM D3776	10 oz./yd.
Grab Tensile	ASTM D4632	270 lbs.
Puncture	ASTM D4833	150 lbs.
Flow Rate	ASTM D4491	70 gal./min./ft.^{2}
Permitivity	ASTM D4491	1.3 sec^{-1}
UV Resistance	ASTM D4355	70%
AOS % Retained	ASTM D4751	100
Seam Strength	ASTM D4884	100 lbs./in.
All properties are minimum average roll value except the weight of the fabric which is given for information only.		

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4. Manufacturer:
   a. ACF Environmental, Dirtbag.
   b. Or Approved Equal.

F. Inlet Sediment Control Device (ISCD):
1. Woven geotextile fabric sack sewn with double needle machine using high strength thread. Geotextile fabric sack to have an average wide width strength of 100 lb/in per ASTM D4884.
2. Provide ISCD manufactured to fit openings of the inlets.
3. Provide ISCD with integral dump straps, lifting loops and restraining strap.
4. Properties:

PROPERTY	TEST METHOD	TEST RESULT
Grab Tensile	ASTM D4632	300 lbs.
Grab Elongation	ASTM D4632	20 Percent
Puncture	ASTM D4833	120 lbs.
Mullen Burst	ASTM D3786	80 psi
Trapezoid Tear	ASTM D4533	120 lbs
UV Resistance	ASTM D4355	80%
Apparent Opening Size	ASTM D4751	40 US Sieve
Flow Rate	ASTM D4491	40 Gal/Min/Sq. Ft.
Permittivity	ASTM D4491	0.55 sec-1
All properties are minimum average roll values.		

5. Manufacturer:
   a. ACF Environmental, Siltsack.
   b. Or Approved Equal.

G. Rock Filters:
1. Aggregate Rock - AASHTO No. 57.
2. Rip-Rap Rock – Provide NSSGA Class Size Number as indicated on Drawings.

H. Sediment Basins (Ponds): Materials in accordance with Erosion and Sedimentation Control Plan Details and Notes.

2.03 TEMPORARY SEEDING MIXTURES

A. As indicated on the Drawings.

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2.04 SOIL SUPPLEMENT MATERIALS

A. As specified in Section 02312.

2.05 MULCHING MATERIALS

A. Mulches: As specified in KYTC Section 827.05.

B. Asphalt Materials for Mulch: As specified in KYTC Section 827.06.

PART 3 EXECUTION

3.01 INSTALLATION

A. Erosion Control Devices: Provide in place prior to start of construction in any area.
   1. Sediment Basins:
      a. Provide sedimentation basins prior to performing excavations. Provide as indicated on Drawings or as directed by Engineer to remove sediment from storm water runoff or dewatering activities.
      b. Remove sediment and restore basin to its original dimensions when sediment has accumulated to cleanout depth indicated on Drawings.
      c. Remove sedimentation trap from service when disturbed areas have been properly stabilized. Convert to a detention basin and stabilize affected area as indicated on the Drawings.
   2. Rock Filter: Provide where indicated on Drawings or as directed by Engineer and as indicated on the Drawings to remove sediment. Place rock to produce an even distribution of rock pieces, with minimum voids. Remove rock filter material when clogged with sediments. Filter materials shall be washed completely free of sediment, or new rock used to rebuild the filter
   3. Silt Barrier Fence: Install fence near limits of excavation or fills where indicated on Drawings or as directed by Engineer to control erosion until disturbed areas are permanently stabilized.
      a. Construct silt barrier fencing with geotextile material with wire or plastic mesh support fencing fastened to support posts. Overall height of fabric above ground to be as indicated on the Drawings. Provide geotextile material of width required including a 12 inch section for embedment.
      b. Excavate a trench 6 inches wide by 6 inches deep on fabric side of barrier and along inside of post line.
      c. Install posts a minimum of 18 inches deep, by an approved method, on downstream edge of trench at a maximum spacing of 10 feet.
      d. Provide wire or plastic mesh support fence when used, of sufficient height to extend from top of fabric to ground or into excavated trench and be securely fastened to posts. Provide staples for wood posts and tie wires for steel and plastic posts, with a minimum of three fasteners per post.
      e. Secure geotextile fabric material by fasteners to top of wire mesh and posts, keeping sag to a minimum, and at a maximum spacing of 30 inches. Extend fabric 12 inches into excavated trench for embedment. Backfill and compact

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over geotextile material to prevent water from flowing under fabric. Overlap fabric roll ends a minimum of 6 inches at post locations.

f. Preassembled silt barrier fence systems to be approved by Engineer. Install preassembled fence systems in accordance with manufacturer's recommendations.

g. Construct silt barrier fence across a ditch or swale area of sufficient length to eliminate end flow, with ends pointing upstream and upslope.

h. Maintain silt barrier fence satisfactorily to keep functional. This includes removal of trapped sediment and cleaning fabric of trapped sediment by tapping fabric material when dry. Replace fabric not functioning due to clogging, damage or deterioration as directed by Engineer.

i. Remove fencing when no longer required, as determined by Engineer. Dispose of fencing materials in a suitable manner and restore area where fence had been erected at no additional cost to Owner.

4. Pumped Water Sediment Control Device (PWSCD):
   a. Install the PWSCD on a slope. It should be placed so the incoming water flows into the bag and will flow through the PWSCD and then flow off the site without creating more erosion. The neck of the PWSCD should be tied off tightly to stop the water from flowing out of the PWSCD without going through the walls of the bag. To increase the surface area being used, the PWSCD may be placed on a gravel bed to allow water to flow in all directions.
   b. The PWSCD is considered full and should be disposed when it is impractical for the bag to filter the sediment out at a reasonable flow rate and should be replaced with a new PWSCD.
   c. Disposal may be accomplished as directed by the Engineer. If the site allows, the PWSCD may be buried on site and seeded, visible fabric removed and seeded or removed from site to a proper disposal area.
5. Inlet Sediment Control Device (ISCD):
   a. Installation and emptying instructions in accordance with manufacturers printed instructions.
6. Temporary Seeding and/or Mulching:
   a. General: Engineer reserves right to direct temporary seeding and/or mulching of disturbed areas in event permanent grading and seeding cannot be immediately performed. Include cost of temporary erosion control measures in appropriate pay item.
   b. Liming: Lime application rates will be determined on basis of tests performed by Contractor or apply a minimum of 800 pounds of agricultural lime stone per 1000 square yards.
   c. Fertilizer: Apply fertilizer at a rate of 140 pounds per 1000 square yards of 10-20-20 fertilizer or in conformance with results of soil tests performed.
   d. Tilling: Till seedbed to a depth of 3 inches prior to seeding. Lime (if required) and fertilizer may be applied during tilling operation.
   e. Seeding: Type of temporary seed mixture to be used is determined by Engineer. Sow seed at rate indicated in Temporary Seeding Mixtures Article. Cover seed with 1/2 inch of topsoil and lightly roll seeded area.

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f. Mulching: Apply hay or straw mulch at rate of three tons per acre on slopes of 1.5 to 1 or flatter. Apply asphalt material to anchor mulch at rate of 50 gallons per ton on straw or hay mulch. Apply wood cellulose fiber mulch on slopes steeper than 1.5 to 1 at a rate of 1500 pounds per acre. Wood chips, recovered from clearing and grubbing operations, is acceptable as mulch for temporary seeding. Use at a rate of 35 cubic feet per acre in lieu of straw or hay.

7. Mulching Alone: For embankments or cuts 1.5 to 1 or flatter, susceptible to critical erosion during periods of cold weather or other site conditions, Engineer may require a three ton per acre application of straw or hay mulch for temporary erosion control and later seeding. Apply asphalt for anchoring mulch at a rate of 50 gallons per ton. Straw or hay may be rolled immediately with a sheepsfoot roller to anchor mulch in lieu of using asphalt. When weather becomes favorable, seed areas provided with a mulch cover alone using normal application rates of seed, fertilizer and lime. If additional mulch is needed, rate of application and area to be mulched will be as determined by Engineer.
8. Matting for Erosion Control: Provide matting in lieu of mulch on slopes 3:1 and steeper, grass channel lining, or when directed by Engineer.
   a. Prepare area to be covered as a fine seedbed, fertilized and seeded. Place matting immediately and water to give a firm bond to soil and start germination of seed. Either jute or excelsior matting may be used.
   b. Staples: Hold matting in place by means of wire staples driven at a 90 degree angle to soil surface. Space staples not more than 3 feet apart in three rows for each strip, with one row along each edge and one row alternately spaced in middle. Space staples 6 inches apart across matting ends and check slots width.

3.02 MAINTENANCE

A. Begin maintenance operations immediately and continue throughout construction period until Contract is completed. Inspect sediment control structures and repair after each storm.

3.03 SOIL EROSION AND SEDIMENTATION PLAN

A. An approved Erosion and Sedimentation Control Plan is indicated on Drawings. Should Contractor desire to modify this Plan, obtain necessary approvals prior to implementing any provisions at no additional cost to Owner.

END OF SECTION

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EROSION & SEDIMENTATION CONTROLS
CONTRACTOR'S INSPECTION REPORT

Project: _____ Project No. _____

Contractor: _____ Date of Inspection: _____

Owner: _____

NOTE: This form is to be completed by the Contractor to document the inspection of the erosion and sedimentation control devices / facilities at least once every seven (7) calendar days and following any rain event of 1/2 inch or greater within a twenty-four (24) hour period.

INSPECTION CHECK LIST:

- Washouts of any temporarily seeded areas. ☐ Yes ☐ No

  If yes, describe location and when area will be repaired: _____

  _____

  _____

- Straw bale barriers: Currently in use: ☐ Yes ☐ No
  In place, no repair required: ☐ Yes ☐ No
  Number of bales replaced: _____ Each
- Silt Fencing: Currently in use: ☐ Yes ☐ No
  In place, no repair required: ☐ Yes ☐ No
  Amount replaced / repaired: _____ L.F.
- Catch Basin/Inlet protection: Currently in use: ☐ Yes ☐ No
  In place, no repair required: ☐ Yes ☐ No

  If yes, describe location and type of repair: _____

  _____

  _____

- Construction Entrances: Currently in use: ☐ Yes ☐ No
  In place, no repair required: ☐ Yes ☐ No
- _____ Currently in use: ☐ Yes ☐ No
  In place, no repair required: ☐ Yes ☐ No
- _____ Currently in use: ☐ Yes ☐ No
  In place, no repair required: ☐ Yes ☐ No
- Comments on any items not included above: _____

  _____

  _____

  _____

Inspected By: _____
Contractor's Representative

SECTION 02510

WATER SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for water main pipe, fittings, valves, and appurtenances.

B. Related Sections:
1. Products: Section 01600.
2. Disinfection of Water Mains: Section 01656.
3. Testing of Piping: Section 01666.
4. Trenching: Section 02324.
5. Paints and Coatings: Section 09900.

1.02 REFERENCES

A. American National Standards Institute:
1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings.
2. ANSI/NSF Standard 61 Drinking Water System Components.

B. American Society for Testing and Materials:
1. ASTM A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
2. ASTM A536, Standard Specification for Ductile Iron Castings.
3. ASTM B88, Standard Specification for Seamless Copper Water Tube.
4. ASTM B687, Standard Specification for Brass, Copper, and Chromium Plated Pipe Nipples.
5. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Schedules 40, 80 and 120.
6. ASTM D2466, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
7. ASTM D2564, Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

C. American Water Works Association:
1. AWWA C104/A21.4, American National Standard for Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
2. AWWA C105/A21.5, American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
3. AWWA C110/A21.10, American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 inch through 48 inch (76 mm Through 1,219 mm), for Water.
4. AWWA C111/A21.11, American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. AWWA C150/A21.50, American National Standard for Thickness Design of Ductile-Iron Pipe.

6. AWWA C151/A21.51, American National Standard for Ductile-Iron Pipe Centrifugally Cast for Water or Other Liquids.
7. AWWA C153/A21.53, American National Standard for Ductile-Iron Compact Fittings, 3 for Water Service.
8. AWWA C502, Standard for Dry-Barrel Fire Hydrants.
9. AWWA C504, Standard for Rubber-Seated Butterfly Valves.
10. AWWA C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.
11. AWWA C512, Standard for Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
12. AWWA C600, Standard for Installation of Ductile-Iron Water Mains and Their Appurtenances.

D. Steel Structures Painting Council:
   1. Surface Preparation Specifications:
      a. SSPC-SP 10, Near-White Blast Cleaning.

1.03 SUBMITTALS

A. Shop Drawings and Product Data: Submit Shop Drawings, Catalog Cuts or other data for products furnished in accordance with Section 01330.

B. Certificates:
   1. Certified records or reports of results of shop tests, to contain a sworn statement that shop tests were made as specified.
   2. Manufacturer's affidavit stating that products furnished comply with applicable provisions of referenced standards and modifications described in this Section.

1.04 QUALITY ASSURANCE

A. Provide piping and components of water systems coming in contact with potable water conforming to ANSI/NSF Standard 61.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Transport, handle and store pipe materials and other specified products as recommended by respective manufacturers and supplemented in this Section, to prevent damage and defects.

1.06 PROJECT CONDITIONS

A. Inspection:
   1. Items of material furnished under this Section will be inspected prior to installation.

B. Environmental Requirements:
   1. Keep trenches dewatered while installing pipe until required pipe joints are made and trench backfilled above water table.
   2. Under no circumstances lay pipe in water or on bedding containing frost.

3. Do not lay pipe when weather conditions are unsuitable, as determined by Engineer, for pipe laying work.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Ductile Iron Pipe (DIP):
   1. Pipe: Manufactured to conform to AWWA C151/A21.51, latest edition.
   2. Wall Thickness: Determined in accordance with AWWA C150/A21.50, latest edition. Minimum wall thickness Class 50:
   3. Joints:
      a. Provide push-on, mechanical, or restrained joints for pipe installed underground. Areas where restrained joints are required are indicated on Drawings.
      b. Push-on, restrained, and mechanical joints to conform with applicable provisions of AWWA C111/A21.11.
   4. Pipe Lining: Cement mortar lined in accordance with AWWA C104/A21.4, double thickness, and asphaltic seal coated in accordance with Section 4-11, Seal Coat, of AWWA C104/A21.4. Provide ANSI/NSF Standard 61 approved seal coatings. Seal coat must have been applied to pipe a minimum of 30 days prior to delivery of pipe to job site.
   5. Outside Pipe Coatings: Asphaltic coating in accordance with Section 51-8, Coatings and Linings, AWWA C151/A21.51.
   6. Manufacturers:
      a. U.S. Pipe.
      b. American.
      c. Clow.
      d. Griffin.
      e. Atlantic States.

B. Fittings:
   1. Gray iron or ductile iron conforming with applicable provisions of AWWA C110/A21.10 or ductile iron compact fittings conforming to AWWA C153/A21.53. Minimum working pressure rated at 250 psi.
   2. Fittings to be mechanical or restrained joint conforming with applicable provisions of AWWA C111/A21.11.
   3. Fitting Lining: Cement mortar lined in accordance with AWWA C104/A21.4, double thickness, and bituminous seal coated in accordance with Section 4-12, Seal Coat, of AWWA C104/A21.4. Seal coatings ANSI/NSF Standard 61 approved.
   4. Fitting Coatings: Standard bituminous coating in accordance with Section 51-8, Coatings and Linings, AWWA C151/A21.51.

C. Joint Material for Ductile Iron Pipe or Fittings:
   1. Push-on Joints:
      a. Ductile Iron Pipe: Conforming to requirements of AWWA C111/A21.11.

2. Mechanical Joints:
   a. Ductile Iron Pipe and Fittings: Conforming to requirements of AWWA C111/A21.11.
   b. Provide mechanical joints with retainer glands.
3. Ductile Iron Pipe Restrained Joints: Conforming to applicable provisions of AWWA C110/A21.10 and AWWA C111/A21.11.
   a. Manufacturers:
      1) United States Pipe & Foundry Company, TR Flex restrained joint, 4 inches to 54 inches.
      2) Clow Corporation, Super-Lock restrained joint.
      3) American Cast Iron Pipe Company, Flex-Ring restrained joint, 4 inches to 48 inches; Lok-Ring restrained joint, 42 inches and larger.
      4) Griffin Pipe Products Co., Snap Lok restrained joint pipe.
      5) Atlantic States, Push-on restrained joint.
      6) Restrained joints for raw water discharge piping from the raw water pumping station up the bluff: American Cast Iron Pipe Company, Flex-Ring restrained joint.
   b. Provide restrained fittings with identical joints as restrained joint pipe in restrained areas.
   c. Valves with mechanical joints in restrained areas to be provided with adaptor pieces with the spigot ends modified to provide a restrained joint, using a welded ring and a second follower gland by restrained bell or restrained spigot ends similar to American MJ Coupled Joint. (Pipe supplier to submit detailed sketch of proposed restraining system for the Engineer's approval).
4. Wedge Action Retainer Glands:
   a. Provide retainer glands for use on mechanical joints on fittings and valves 24 inches or less. Use fully restrained type joints on fittings and valves greater than 24 inches. Retainer glands on fittings and valves greater than 24 inches not acceptable.
   b. Retainer glands not acceptable in lieu of restrained joints.
   c. Mechanical joint retainer glands cast from ASTM A536, Grade 65-45-12 ductile iron. Wedging mechanism manufactured of ductile iron, heat treated to a hardness of 370 BHN minimum. Provide retainer glands with dimensions that can be used with standardized mechanical joint bell and tee head bolts conforming to requirements of AWWA C111/A21.11 and AWWA C153/A21.53. Wedge action screws incorporate twist off nuts in design to ensure proper torque. Provide mechanical joint restraining device for water working pressure rating of 250 psi minimum with a safety factor of at least 2:1.
   d. Install mechanical joint retainer glands in accordance with manufacturer's recommendations. Apply torque to T- bolts in accordance with manufacturer's recommendations. Tighten torque limiting twist off nuts in alternate manner and clockwise direction. Apply joint deflection before T-bolts are torqued. Where retainer glands are used, limit joint deflection to 2-1/2 degrees maximum.
   e. Provide retainer glands designed to prevent joint separation under following pressure ratings:

Size (Inches)	Pressure Rating (psi)
6	350
8	350
10	350
12	350
16	350
20	250
24	250

f. Manufacturer:
   1) EBAA Iron, Inc., Series 1100 (Megalug).
   2) Ford Meter Box Co., Inc.; Series 1400 (Uni-Flange).

D. Schedule Type Polyvinyl Chloride (PVC) Pipe: Schedule 40, Type I PVC conforming to ASTM D1785 requirements for pipe, and ASTM D2466 for fittings.
   1. Solvent-Weld Joints: Conforming to ASTM D2564 requirements.

E. Small Piping: Small piping shall include piping 2-1/2 inches and smaller. The piping shall include sensing lines and water service lines. The pipe material shall be as shown on the Drawings. Copper tubing shall be used on sensing and water service lines 2 1/2 inches and smaller, except where noted otherwise.
   1. Copper Tubing: Copper tubing when used underground shall be Type "K" annealed. All fittings used underground shall be of the compression pattern, flared type for copper water service.
      a. Copper tubing used inside the chambers and encasing conduit shall be Type "L", hard drawn, unless the copper tubing supports a piece of equipment, such as an air release valve, in which case the copper tubing shall be Type "K". All changes shall be made with fittings. Fittings shall be cast or wrought bronze or wrought copper of the solder joint type.
      b. All copper tubing shall conform to the requirements of ASTM B88.
   2. Pipe Nipples: ASTM B687 threaded brass nipples.

2.02 VALVES, HYDRANTS, AND OTHER WATER MAIN ACCESSORIES

A. Gate Valves: Provide valves and operators conforming to AWWA C509 3 through 30 inches in size to be iron body, resilient-seated nut operated, non-rising stem, inside screw gate valves suitable for buried service.

1. 3 Through 12 Inch: Design valves for an operating pressure of 200 psi. Test pressures to 400 psi. Design valves to operate in vertical position.
2. 14 Through 30 Inch: Design valves for an operating pressure of 150 psi. Test pressures to 300 psi. Provide valve for buried service installed in the horizontal position and activated through a bevel gear unit mounted on the valve.
3. Shop Drawing: Furnish Shop Drawings from manufacturer showing principal dimensions, construction details, and materials used for valve parts.
4. Size and Quantity: As indicated on Drawings.
5. Valve Ends: Mechanical joint in accordance with AWWA C111/A21.11 with wedge action mechanical joint retainer glands, except in restrained area.
6. Stem Seal: Use Double O ring stem seals.
7. Operating Nuts and Direction of Opening: Square operating nuts conforming to AWWA C509. Valves to open Counterclockwise (Left).
8. Manufacturers:
   a. American Flow Control.
   b. Clow.
   c. ITT Kennedy Valve.
   d. Mueller Company.
   e. U.S. Pipe.

B. Butterfly Valves: Provide valves and operators conforming to AWWA C504, Rubber-Seated Butterfly Valves, except as modified in this Section.
1. Construct valve disc from cast iron or ductile iron.
2. Valve Seats: New natural or synthetic rubber, recess mounted, bonded or mechanically secured to valve body or disc. If seats are recess mounted on valve disc, furnish as mechanically received with stainless steel retainers and stainless steel screws. Also when seats are recess mounted on discs, furnish stainless steel body seat rings, recessed and bonded into valve body. When seat is in body, furnish cast iron disc with stainless steel seating edge or corrosion resistant 80 percent nickel/20 percent chrome seating edge.
3. Provide stuffing boxes or "O" ring where valve shaft extends through valve body.
4. Valve Shaft: Stainless steel or monel, straight through or two piece.
5. Shaft Seals: Self compensating V-type packing.
6. Shaft Bearings: Self lubricating sleeve type. Provide adequate thrust bearings to keep disc centered regardless of valve position or have center thrust surfaces integral to valve disc.
7. Provide valves with mechanical joint ends and wedge action mechanical joint retainer glands, except in restrained areas.
8. Design valves to operate under a system pressure of 150 psi and maximum velocity of 8 ft./sec.
9. Operators:
   a. Nut operated and suitable for buried service. Provide each operator with ground level position indicator, Pratt Diviner.
   b. Provide nut operators of worm gear or lead screw type, self-locking and designed to hold valve in intermediate position between fully open and fully closed without creeping or fluttering. Provide operators with mechanical stop-limiting devices to prevent overtravel of disc in open and closed position.

Operators to be fully enclosed and designed to produce specified torque with a maximum input of 150 pounds on operating nut. Operator components to withstand an input of 300 foot-pounds at extreme operator position without damage. Design operators in accordance with AWWA C504. Valves to open Counterclockwise (Left).

10. Coatings: Valve interior and exterior exposed surfaces susceptible to corrosion to be coated with minimum two coats of polyamidoamine epoxy minimum 8 mils dry film thickness prior to assembly of valves. Coatings to be ANSI/NSF Standard 61 approved for potable water. Prepare and blast clean surfaces to be coated per Steel Structures Painting Council Specification SSPC-SP-10-638 No. 10. All surfaces to be inspected for proper dry film thickness using magnetic dry film thickness gauge.
11. Manufacturers:
    a. Henry Pratt
    b. DeZurik

C. Eccentric Plug Valve:
1. The eccentric plug valve shall be of semi-steel body and plug conforming to ASTM A126, Class B, with a pressure rating of 150 psi. The plug shall be coated with rubber. The bearings shall be of corrosion-resistant material. Seats shall be nickel alloy or stainless steel.
2. The valve shall be of the nonlubricated eccentric type with flanged ends. The flanges shall be faced and drilled to ANSI B16.1, 125-pound standard.
3. The exterior of the valve shall be painted in accordance with Section 09900, of these Specifications.
4. The valve shall be nut operated as indicated on the Drawings and shall open to the left. Position indicators shall be provided.
5. Manufacturers:
    a. DeZurik.
    b. Henry Pratt.

D. Combination Air Valve: Air valve conforming to AWWA C512. Air release portion functions to vent air accumulating at high points in water main. Air/vacuum valve portion exhausts larger quantities of air present in system during filling of water main and allows air to re-enter main during draining of pipe.
1. Construction:
    a. Cast iron body and cover.
    b. Stainless steel float and parts.
    c. Buna-N seat.
2. Air Release Orifice Size: 3/32 inch for 3 and 4 inch sizes.
3. Inlet Size: 3 inch and 4 inch.
4. Maximum Working Pressure: 150 psi.
5. Size and Quantity: As indicated on Drawings.
6. Manufacturers:
    a. Val-Matic Valve and Manufacturing Corp.
    b. APCO Valve and Primer Corp.
    c. G. A. Industries, Inc.

E. Fire Hydrants:
   1. Design: Compression type, traffic type with breakable safety flange and stem coupling. Conform to requirements of AWWA C502.
      a. Hydrant Seat Opening: 5-1/4 inch.
      b. Inlet: 6 inch mechanical joint.
      c. Pumper Nozzle, Hose Nozzle, and Operating Nut.
         1) See hydrant detail on Drawings.
         2) Painting: Exposed portion to be painted a color as selected by Owner.
   2. Swivel Hydrant Piping: Provide a swivel by solid adapter from mechanical joint tee to mechanical joint valve and swivel by solid adapter from mechanical joint valve to mechanical joint hydrant of length as required, and as indicated on Drawings. Provide swivel adapters manufactured by Tyler Pipe.
   3. Manufacturer:
      a. American Darling.

F. Valve Boxes: Provide cast iron valve boxes of two piece or Buffalo Type for valves up to 12 inch and of three piece for valves larger than 12 inch buried in ground. Valve box design of adjustable two section screw type telescoping column or three section with separate base, column inside diameter of 5-1/4 inches, and furnished with a cover marked WATER. Hot coat inside and out with tar or asphalt compound.

2.03 SOURCE QUALITY CONTROL

A. Tests, Inspection:
   1. Ductile Iron Pipe: Test in accordance with AWWA C151/A21.51.
   2. Fittings: Test gray-iron and ductile-iron fittings in accordance with AWWA C110/A21.10). and AWWA C153/A21.53) Compact Fittings.

PART 3 EXECUTION

3.01 RESPONSIBILITY FOR MATERIAL

A. Carefully examine material for defects, and do not install material known to be defective.

B. Replace material found defective in manufacture or damaged in transit or handling at no additional expense.

C. Remove defective material from jobsite.

3.02 DEFECTIVE PIPE

A. Engineer reserves right to reject defective pipe shipped to jobsite or stored on site. Engineer will examine pipe and determine if pipe is damaged prior to installation in trench. Failure of Engineer to detect damaged pipe does not relieve Contractor's total responsibility for pipe if it leaks or breaks after installation. Set defective pipe and fittings aside for final inspection by Engineer to determine if corrective repairs can be made, or material rejected. Engineer will determine extent of repairs. Classify defective pipe as follows:

1. Damage to interior and exterior paint seal coats.
2. Damage to interior cement-mortar lining.
3. Insufficient cement-mortar lining thickness.
4. Poor quality interior paint seal coat.
5. Pipe out of round.
6. Damage pipe barrel area to point where pipe class thickness is reduced.
7. Denting or gouges in plain end of pipe.

3.03 HANDLING OF MATERIAL

A. Handling of Pipe and Fittings:
   1. Unload, handle and store ductile iron pipe, fittings, valves and appurtenances in accordance with AWWA C600. If damage or coating abrasion occurs and is deemed repairable, repair as directed by Engineer, in accordance with manufacturers recommendations. If damage is not repairable in opinion of Engineer, reject pipe, fittings, valves or appurtenances, remove from Project site and replace at no additional expense.
   2. Keep fittings and valves drained and stored before installation in a manner protecting them from damage due to freezing of trapped water in accordance with Section 01600.

3.04 CLEANING PIPE AND FITTINGS

A. Clean and remove foreign matter from pipe, fittings and valves before placing in trench. Remove pipe and fittings if interior has been contaminated with oil, gasoline, kerosene or other material damaging to bituminous seal coat or cement-mortar lining and replace at no cost to Owner. Should foreign material or contaminates be observed in previously installed pipe, cease work until foreign material or contaminated pipe is decontaminated or removed.

B. Close open ends of pipe with a watertight plug when pipe laying is not in progress.

3.05 ALIGNMENT AND GRADE

A. Lay and maintain pipe at required lines and grades as indicated on Drawings. Place fittings and valves at required locations with joints centered, spigots forced home, and valve stems plumb. Do not deviate from required line and grade, except with approval of Engineer.

B. Joint Deflection:
   1. Maximum allowable deflection at joints for push-on joint pipe as follows:

Size of Pipe	Deflection Angle (Degrees)	Maximum Deflection (18 ft. Length)	(20 ft. Length)
Thru 12"	2-1/2	9-1/2"	10-1/2"
14"-36"	1-1/2	5-1/2"	6"
42"-48"	1	3-3/4"	4"

   2. If curve is too sharp for allowable deflection, short lengths of pipe may be used upon approval of Engineer.

C. Where underground conditions indicate a change of alignment or grade, make change only with written consent of Engineer. When a change in grade is indicated resulting in pipe having more cover than originally anticipated, carefully review class of pipe scheduled for installation at location to ensure it can withstand new loadings. If it cannot, replace with proper class of pipe, as directed by Engineer.

D. Except at points indicated on Drawings, exercise particular care that no high points are established where air can accumulate. In event field conditions necessitate a change in pipe profile and, in opinion of Engineer, resulting change requires installation of an air valve and manhole, install as additional and extra work in accordance with Article 2.30 of General Conditions. If Contractor requests a change in pipe profile to facilitate construction, and resulting change requires installation of an air valve and manhole at high points due to requested change, cost of furnishing and installing air valve and manhole is at Contractor's expense.

3.06 LAYING PIPE

A. General Requirements: Use proper and suitable tools and appliances for proper and safe handling, lowering into trench and laying of pipes.
   1. Do not lay pipe in a wet trench, on subgrade containing frost, and when trench conditions are unsuitable for pipe laying work. If efforts fail to obtain a stable dry trench bottom and Engineer determines trench bottom is unsuitable for trench foundation, he will order in writing type of stabilization to be constructed.
   2. Thoroughly clean pipes and fittings before installing and keep clean until acceptance of completed work.
   3. Lay pipe with bell ends facing in direction of laying, unless otherwise indicated on Drawings, or directed by Engineer.
   4. Exercise care to ensure each length abuts next effecting no shoulder or unevenness occurs in pipeline.
   5. No wedging or blocking permitted in laying pipe unless by written order of Engineer.

6. Before joints are made, bed each section of pipe full length of barrel with recesses excavated so pipe invert forms continuous grade with invert of pipe previously laid. Do not bring succeeding pipe into position until preceding length is embedded and securely in place.
7. Dig bell holes sufficiently large to permit proper joint making and to ensure pipe is firmly bedded full length of its barrel.
8. Walking or working on completed pipeline, except as required in tamping and backfilling, not permitted until trench is backfilled one foot deep over top of pipes.
9. Take up and relay pipe that is out of alignment or grade, or pipe having disturbed joints after laying.
10. Take up and replace with new, at no additional expense, in-place pipe sections found to be defective.
11. Take necessary precautions to prevent floating of pipeline by accumulation of water in trench, or collapse of pipeline. Should floating or collapse occur, restore at no additional expense.
12. Bedding materials and concrete work for pipe bedding as specified previously in Section 02324.
13. Take every precaution to prevent foreign material from entering pipe while it is being placed in line. During laying operations, do not place debris, tools, clothing, or other materials in pipe.
14. Close openings in pipeline with watertight plugs when pipe laying is stopped at close of day's work or for rest breaks, meal periods or other reasons.
15. Place enough backfill over center sections of pipe to prevent floating.
16. Place underground warning tape over pipeline as specified in Section 02324.
17. Carry out cutting of pipe with an abrasive wheel, rotary wheel cutter, guillotine pipe saw, milling wheel saw or other equipment specifically designed for that purpose. Use of chisels or hand saws not permitted. Grind smooth cut ends and rough edges and for push-on connections, cut end should be beveled slightly.

B. Joints. Exercise care when making each joint, and make in accordance with pipe supplier's specifications and in accordance with following instructions:
   1. Ductile Iron Pipe:
      a. Push-On Joints: Join pipe in accordance with AWWA C600, Section 3.4.1 or latest revision, and following.
         1) Assemble push-on joint to provide tight, flexible joints that safely permit movement caused by expansion and contraction due to temperature changes and by ground movement.
         2) Thoroughly clean inside of bell and outside of spigot end to remove oil, grit, excess coating and other foreign matter. Flex circular rubber gasket inward and insert in gasket recess of bell socket. Apply a thin film of gasket lubricant to either inside surface of gasket or spigot end of pipe or both. Gasket lubricant to be supplied by pipe manufacturer and approved by Engineer prior to its use.
         3) Enter spigot end of pipe into socket with care to keep joint from contacting ground. Complete joint by forcing plain end to bottom of socket with a forked tool or jack type tool or other device as may be approved by Engineer. Mark pipe that is not furnished with a depth mark before

assembly to ensure spigot end is inserted to full depth of joint. File or ground field cut pipe lengths to resemble spigot end of pipe as manufactured. Complete assembly instructions are available from pipe manufacturer.

b. Mechanical Joint: Furnish sworn statement that inspection and tests on parts of this type joint have been made and met as specified. Join in accordance with AWWA C600, Section 3.4.2., latest revision, and following:

1) Centrally locate spigot in bell. Thoroughly brush contact surfaces of rubber gasket seal with a wire brush just prior to assembly. Remove loose rust or foreign material and brush with soapy water prior to slipping gasket over spigot end and into bell. Normal range of bolt torques applied to standard cast iron bolts in joint are as follows:

Size Inches	Range of Torque Ft. - Lb.
5/8	40-60
¾	60-90
1	70-100
1-1/4	90-120

2) Above torque loads may be applied with torque measuring or indicating wrenches. Torque wrenches may be used to check application of approximate torque loads applied by men trained to give an average pull on a definite length of regular socket wrench. Following lengths of wrenches should satisfactorily produce above range of torques when used by average man:

Size Inches	Length of Wrench Inches
5/8	8
3/4	10
1	12
1-1/4	14

3) When tightening bolts, it is essential that gland be brought up toward pipe flange evenly, maintaining equivalent distance between gland and face of flange at all points around socket. This may be done by partially tightening bottom bolt first, then top bolt, next bolts at either side, and last, remaining bolts. Repeat this cycle until bolts are within above range of torques. If

effective sealing is not attained at maximum torque indicated above, disassemble and reassemble joint after thorough cleaning. Avoid overstressing of bolts to compensate for poor installation practice.

c. Retainer Glands: Install retainer glands as with mechanical joints, except after joint bolts are tightened, tighten restraining screws in retainer gland. Required torque range for retaining screws as specified by retainer gland manufacturer.

d. Restrained Joints: Install in accordance with manufacturer's recommendations.

2. Flexible (Ball and Socket) Joints: Install in accordance with manufacturer's recommendations.

3.07 SEPARATION OF WATER MAINS, SANITARY SEWERS AND STORM SEWERS

A. Parallel Installation: Lay water mains at least 10 feet horizontally from any existing or proposed sewer. Distance to be measured edge-to-edge.

B. Crossings: Whenever water mains must cross building drains, storm drains or sanitary sewers, lay water main at such an elevation that the bottom of the water main is 18 inches above the top of the drain or sewer. Maintain vertical separation for the portion of the water main located within 10 feet horizontally of any sewer or drain it crosses. The 10 feet is to be measured as a perpendicular distance from the drain or sewer line to the water line.

C. Where water mains must cross under building drains, storm drains or sanitary sewers, additional protection shall be provided by all of the following:

1. A vertical separation of at least 18 inches between the bottom of the sewer and the top of the water line
2. Adequate structural support for the sewers to prevent excessive deflection of the joints and the settling on and breaking of the water line
3. Center a full length of the water line at the point of the crossing so that the pipe joints shall be equidistant and as far as possible from the sewer.

D. Sewer Manholes: No water pipe is allowed to pass through or come in contact with any part of a sewer manhole.

E. Exceptions: Where it is impossible to obtain the proper horizontal and vertical separation as stipulated above, deviations to these requirements may be made in accordance with DEP requirements and with Engineer's approval.

3.08 INSTALLATION OF POLYETHYLENE TUBING ON DUCTILE IRON PIPE.

A. Install polyethylene tubing around ductile iron pipe and appurtenances. Prior to installation of first pipe and polyethylene tubing, arrange a meeting between a representative of pipe manufacturer, Engineer, and his supervisory personnel. Purpose of meeting is have representative of pipe manufacturer review, expound, and demonstrate following procedure for installing polyethylene tubing, answer questions, and observe installation of at least three lengths of ductile iron pipe with polyethylene tubing.

B. Install polyethylene tubing in accordance with AWWA C105/A21.5, method A, as described below:
   1. Raise a length of pipe at side of trench to a height of about 3 feet above ground level by means of hoisting equipment and a pipe sling or tongs. Using a precut length of polyethylene tubing (approximately 2 feet longer than length of pipe to be covered), slide polyethylene tubing over bell end of pipe. Inspect material for cuts. If there is a cut, Engineer will decide whether material can be repaired by taping Polyken No. 900, or Scotchrap No. 50, or whether material be replaced at no additional expense to Owner. After material is approved or replaced, bunch polyethylene tubing near bell end of pipe.
   2. Lower pipe into trench. Affect joining of lowered length to previously laid pipe. Shallow bell holes at pipe joints facilitate overlapping of polyethylene tubing at pipe joints.
   3. Raise bell end of newly laid pipe clear of trench bottom. Pull polyethylene tubing along remainder of pipe length to spigot end of recently affected joint. Leave surplus bunched at bell end for subsequent covering of next joint.
      a. Take care not to allow foreign material from getting between polyethylene tubing and pipe. If it does, completely remove foreign material before proceeding to next phase of installation.
   4. Cover joint by pulling polyethylene tubing from previously laid pipe over bell. Fold polyethylene tubing around spigot end of pipe being laid, and wrap with at least three circumferential turns of specified 2 inch wide plastic tape to hold polyethylene tube around spigot end.
   5. Pull polyethylene tubing on pipe being laid over polyethylene tubing already covering joint, as specified above. Overlap at least 1 foot. Neatly fold polyethylene tubing and hold it in place by at least three circumferential turns of specified 2 inch wide plastic adhesive tape.
   6. To eliminate voids and pockets in loose polyethylene tube material covering pipe, neatly draw up excess material around pipe barrel, creating a close fit between pipe and material. Fold excess material into an overlap on top of pipe and hold it in place at approximately 3 foot to 5 foot intervals by means of pieces of specified plastic tape.
   7. Backfill around covered pipe in accordance with Section 02324. If a mechanical tamper cuts polyethylene material, remove backfill material, repair cut as approved by Engineer, and backfill trench again in 4 inch layers.

C. Use above procedure for covering pipe bends. Ensure excess material is properly drawn up.

D. Cover tees, valves and irregularly shaped appurtenances, in above manner, except split polyethylene tubing at a suitable length, and fold and tape resulting flat sheet around fitting or valve.

3.09 VALVE INSTALLATION

A. Examination of Material: Prior to installation, inspect valves for direction of opening, freedom of operation, tightness of pressure containing bolting, cleanliness of valve ports

and especially seating surfaces, handling damage and cracks. Correct defective valves or hold for inspection by Engineer.

B. Installation: Set and join to pipe in manner specified in Article 3.06. Provide valves 12 inch and larger with crushed stone or concrete pad support so that pipe does not support weight of valve. Set truly vertical.

C. Valve Protection: Provide valves with a valve box. Set top of valve box neatly to grade of surface of existing ground, unless directed otherwise by Engineer. Do not transfer shock or stress to valve, and center and plumb box over wrench nut of valve. Do not use valves to bring misaligned pipe into alignment during installation. Support pipe in manner to prevent stress on valve.

3.10 HYDRANT INSTALLATION

A. Location: As indicated on Drawings or as directed by Engineer. Take care to locate hydrant, so that it is completely accessible, but minimizes possibility of damage from vehicles or injury to pedestrians. When placed behind curb, set hydrant barrel so that no portion of pumper or hose nozzle cap is less than 6 inches, nor more than 12 inches from gutter face of curb. When set in lawn space between curb and sidewalk, or between sidewalk and property line, maintain a minimum distance of 6 inches between sidewalk and hydrant caps.

B. Installation: Install in accordance with details indicated on Drawings. Stand hydrant plumb with pumper nozzle facing curb and hose nozzles parallel to curb. Set nozzles at least 12 inches above existing ground, unless otherwise directed by Engineer.
   1. Connection: Connect to main with a 6 inch branch pipe controlled by an independent 6 inch gate valve.
   2. Drainage: Provide at base of hydrant by placing coarse gravel or crushed stone, mixed with coarse sand, from bottom of trench to at least 6 inches above waste opening in hydrant, and to a distance of 1 foot around hydrant base.
   3. Restraint: Brace against unexcavated earth at end of trench with concrete backing.

3.11 THRUST RESTRAINT

A. General: Provide all nonrestrained caps, tees, and bends (both horizontal and vertical) with thrust restraints as detailed on Drawings.

B. Concrete Reaction Backing: Place concrete reaction backing between undisturbed solid ground and fitting to be anchored. Locate backing, unless otherwise shown or directed, to contain resultant thrust force and so that pipe and fitting joints are accessible for repair.

C. Temporary Thrust Restraint: Provide for temporary thrust restraint at temporary caps or plugs. Submit details of temporary restraint to Engineer for approval.

D. Metal Harnessing: At connections with existing water mains where there is a limit on time water main may be removed from service, use metal harnesses of anchor clamps, tie rods and straps; mechanical joints utilizing wedge action retainer glands; or restrained

push-on joints in conjunction with concrete thrust blocks. Metal harnessing may not be used in lieu of concrete backing without approval of Engineer. Submit details of proposed installation to Engineer for approval. For pipe up to 12 inches in size, use a minimum of two 3/4 inch tie rods. For pipe 16 inch in size, four 3/4 inch tie rods are required and for 20 inch pipe, six 3/4 inch tie rods are required. Install retainer glands in accordance with instructions of particular manufacturer furnishing glands.

E. Protection of Metal Harnessing: Protect tie rods, clamps and other components of dissimilar metal against corrosion by hand application of a bituminous coating or by encasement of entire assembly with 12 mil thick, polywrap in accordance with AWWA C105/A21.5. Provide polywrap with the word water printed on it.

3.12 CONNECTIONS TO EXISTING WATER MAINS AND INTERRUPTIONS OF SERVICE

A. Notification: Notify Owner a minimum of 7 working days in advance of anticipated time for installing a connection to water system, or when necessary to close down a portion of existing system to carry out work. Under no circumstances are valves to be manipulated on existing water system, except under direct supervision of a representative of Owner.

B. Owner's Restrictions: Owner reserves right to designate day and time when existing water main may be removed from service. Owner may require that this work be done at night or on a weekend. In addition, Owner further reserves right to require that work on installation of connections between existing and new water mains, or in other areas where service to customers will be interrupted, be carried out continuously and expeditiously until water service is restored.

C. Notification of Customers: Give adequate and timely notice to affected customers that construction will require interruption of service.

D. Installation: In cases where connections to existing water system or other work require an interruption of water service, carefully plan work ahead in close coordination with Engineer and Owner. Obtain Engineer's approval of installation schedule and procedure before work is started, and procure necessary materials, tools and equipment before work is started. Make provision in prices bid for connections, and laying pipe adjacent to existing fittings, for adequate personnel to be available for continuous operations and payment of premium time. No additional or extra payment made for extra personnel and overtime for installation of connections, cutting and capping of existing water mains, or passing of existing fittings, whether or not Owner directs that work be continuous, without interruption, and that this work be at night or on a Sunday.

3.13 FIELD QUALITY CONTROL

A. Hydrostatic Pressure and Leakage Test: Give each water main each Part of Contract a hydrostatic pressure and leakage test in field. Conduct tests meeting approval of Engineer before each water main is accepted.

B. Test in accordance with provisions of Section 01666.

3.14 DISINFECTION OF WATER MAINS

A. Disinfect and flush with water in accordance with provisions of Section 01656 - Disinfection of Water Mains.

END OF SECTION

SECTION 02537

SEPTIC DOSING STATION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provide all labor, materials, equipment and method of installation necessary for the construction of duplex submersible septic dosing station complete with all appurtenances as shown on the Drawings and more fully described hereinafter.

B. Related Sections:
1. Submittals: Section 01300
2. Products: Section 01600
3. Testing: Section 01650.
4. Piping: Division 2
5. Concrete: Division 3
6. Paints And Coatings: Section 09900.
7. Division 16-Electrical.

1.02 REFERENCES

A. Institute of Electrical and Electronic Engineers (IEEE).

B. National Electric Manufacturers Association (NEMA).

1.03 QUALITY ASSURANCE

A. General Requirements: Comply with provisions of Section 01600.

B. Basis of Design: Specifications are based on Myers Pumps. Submit drawings to Engineer for approval.

C. Requirements of Regulatory Agencies: Construction code requirements of State, County or other political subdivision which exceed requirements of national codes, standards and approving bodies to be complied with.

1.04 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for belt filter press equipment in accordance with Section 01300, demonstrating compliance with Specifications.

B. Furnish Engineer with manufacturer's certificate regarding equipment installation prior to initial operation and mechanical performance test.

C. Shop Drawings and Product Data:
   1. Submit in accordance with these Specifications and Section 11005, manufacturer's published detail drawings, modified to suit design conditions if required.
   2. Submit in accordance with these Specifications, manufacturer's descriptive literature and specifications covering product specified. Include installation information, pump component parts drawings, system head curves, motor data, operation and maintenance instructions, etc.

1.05 DESIGN CRITERIA

A. The principal items of equipment in each station shall include two (2) motor driven, submersible grinder sewage pumps, two (2) ball valves, two (2) ball check valves, two (2) pressure gauges, required piping, electrical controls, automatic pumping level controls, access hatches, vent piping, slide rails and hoist, and other required appurtenances and wiring.

B. Submersible Pumps:

Description	Belt Filter Press
General Pump Requirements	
Type of Pump	Grinder
Discharge Size	1-1/4"
Design Points	
Flow	20 GPM
Head	53 TDH
Motor Requirements	
Voltage	460
Horsepower	2
Phase	3
Hz	60

C. Pumps are to be as manufactured by Myers, model WGX-20.

1.06 DELIVERY, STORAGE AND HANDLING

A. Unload equipment with care. In event of damage make repairs or replacements at no increase in Contract Price. Follow manufacturer's instructions for unloading equipment.

B. Store and protect equipment in strict accordance with manufacturer's written instructions.

C. See Section 01600 for general handling, storage, and protection requirements.

PART 2 PRODUCTS

2.01 SUBMERSIBLE GRINDER PUMPS AND APPURTENANCES

A. The pumps shall be grinder sewage pumps capable of operating in a partially or entirely submerged condition. The grinder unit shall be capable of macerating all material in normal domestic and commercial sewage including reasonable amounts of foreign objects such as small wood, sticks, plastic, thin rubber, sanitary napkins, disposable diapers and the like to a fine slurry that will pass freely through the pump and 1-1/4" discharge pipe. Discharge shall be 1-1/4" NPT. The design shall be such that pumping units will be automatically and firmly connected to the discharge piping when lowered into place on the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. The pumps shall be easily removable for inspection or service, requiring no bolts, nuts or other fastenings to be removed for this purpose and no need for personnel to enter the pump well. Each pump shall be fitted with a stainless steel chain of adequate strength and length to permit raising the pump for inspection and removal.

B. All major parts, such as stator casing, oil casing, sliding bracket, volute and impeller shall be of gray cast iron, ASTM A-48, Class 30. All iron castings shall be pre-treated with phosphate and chromic rinse and to be painted before machining and all machined surfaces exposed to the sewage water to be re-painted. All surfaces coming into contact with sewage shall be protected by a coating resistant to sewage. All fasteners to be 302 stainless steel. The common motor pump and grinder shaft shall be of #416 stainless steel threaded to take pump impeller and grinder impeller.

C. The pump impeller shall be of the recessed type to provide an open unobstructed passage through the volute for the ground solids. Impeller shall be of 85-5-5-5 bronze and shall be threaded onto stainless steel shaft. Enclosed or semi-open pump impellers which might become obstructed during grinding or add excessive radial loads shall not be considered as equal. Grinder assembly shall consist of a single rotating grinder impeller and a single stationarily shredding ring mounted directly below pump volute inlet. Grinder impeller shall thread onto shaft and shall be locked with a screw and washer. Shredding ring shall be held in place by a steel retaining clamp. Both assembly shall be necessary for proper grinder operation. Multiple grinder impeller assemblies requiring initial or periodic axial adjustment for proper operation shall not be considered equal. Grinder impeller and shredding ring shall be made of 440C stainless steel hardened to 58-60 Rockwell.

D. Motor shall be protected by two mechanical seals mounted in tandem with a seal chamber between the seals. Seal chamber shall be oil filled to lubricate seal face and to transmit heat from shaft to outer shell. Seal face shall be carbon and ceramic and lapped to a flatness of one light band. Lower seal faces shall be tungsten carbide. A double electrode shall be mounted in the seal chamber to detect any water entering the camber through the lower seal. Water in the chamber shall cause a yellow light to turn on at the control box. This signal shall not stop motor but shall act as a warning only,

C. Joints shall be mortared or grouted; joined with AASHTO M-198-75 preformed flexible butyl type joint sealant, Hamilton-Kent "Kent-Seal No. 2", K.T. Snyder Company "rub'r-Nek", Press Seal Gasket "E-Z Stik", or equal; or joined with bituminous mastic joint sealing compound meeting Kentucky Department of Transportation Specifications 807.02.04. When making joints with mastic compound, prime and seal all joints with primer supplied with the joint compound. Joints shall be watertight.

2.03 ACCESS STEPS

A. Plastic valve vault access steps shall be PSI-PF (Press Fit) polypropylene plastic as manufactured by MA Industries, Peachtree City, Georgia or equal. Steps shall be driven into specially sized holes cast into the valve vault section. Holes shall be formed in the valve vault section using an insert plug which is removed upon curing.

B. Step spacing of 15" is acceptable. Steps shall be equally spaced, the entire depth of valve vault.

2.04 CONCRETE BASES AND TOP SLABS

A. Cast-In-Place Concrete - Reinforced concrete base and top slab shall be 4000 psi concrete of the dimensions shown on the Drawings. Cast-in-place concrete shall be as specified in Division 3.

B. Pre-Cast Concrete - A precast concrete top slab (for the wet well) may be used in lieu of the cast-in-place top slab shown on the Drawings. Reinforcing shall be equivalent to that shown on the Drawings. Wet well access hatch and wet well vent shall be cast in the top slab.

2.05 ACCESS HATCHES

A. Access Hatch for Valve Vault
   1. Access hatch shall be double leaf, aluminum, gutter type, watertight, exterior, flush floor hatch design. Door leaves shall be 1/4 inch aluminum diamond pattern plate to withstand a live load of 300 pounds per sq. ft. Channel frames shall be 1/4 inches aluminum with an anchor flange around the perimeter. Provide 1-1/2 inch female NPT threaded aluminum drainage coupling welded under frame at right front corner for connection of drain pipe.

B. Access Hatch for Wet Well
   1. Access Hatch shall be of the type described in Paragraph A.1, do not require a gutter type channel frame, and shall be furnished with a factory installed net to prevent fall-throughs. Net shall be manufactured by USF Fabrication of Hialeah, Fl (or equal) and shall include high strength polyester netting that has been tested and certified to meet current OSHA standard 1926.5002 (c) (4) (i) drop test, and hardware, hooks and anchors of 316 stainless steel.

C. Door shall be equipped with heavy forged brass hinges, a lockable hasp for use with a padlock, stainless steel pins, spring operator for easy operation and an automatic hold-open arm with release handle. Provide inside stainless steel snap locks with removable wrench lift handle outside. Furnish threaded aluminum plug to seal lock aperture. Hardware shall be cadmium plated.

D. Doors and frames shall be mill finish with bituminous coating applied to the exterior of the frame. Hatches shall have an odor resistant gasket.

2.06 PIPING AND VALVES

A. All inside (pumping station and valve vault) piping shall be Schedule 80 PVC. PVC Pressure Pipe, 3" and Smaller: Polyvinyl chloride plastic pipe shall be ASTM D 1785 Schedule 80 or F441 CPVC, Schedule 80 with solvent weld joints. Fittings shall be ASTM D 2467 Schedule 80 socket type. All socket type connections shall be made with PC solvent cement complying with ASTM D 2564 PVC solvent cement shall be furnished from the same supplier as the PVC pipe. Provide socket-threaded adapters for connection to threaded appurtenances where required.

B. Ballves shall be True Union type ball valves constructed from PVC Type I cell classification 12454 conforming to ASTM D 1784. All O-rings shall be EPDM or Viton. All valves shall have safe-T-shear stem and double stop polypropylene handle. All valve union nuts have shall buttress threads. All valve seal carriers shall be safe-T-blocked. All valve components shall be replaceable. All 2" valves shall be pressure rated at 150 psi for water at 73 °F, as manufactured by Spears Manufacturing Company.

C. Check valves shall be True Union Ball Check Valve type constructed from PVC Type I cell classification 12454. All O-rings shall be E PDM or genuine Viton. All valve unions nuts shall have buttress threads. All valves components shall be replaceable. All 2" valves shall be certified for pressure rated at 235 psi for water at 73 °F, as manufactured by Spears Manufacturing Company.

2.07 PRESSURE GAUGES

A. All indicating gauges are pipe mounted with male and brass threaded pipe connections. Gauges shall be 4 1/2 inch liquid filled for maximum vibration and corrosion protection. Gauges shall have phosphor bronze Bourdon tubes, white laminated phenol dials. Gauges shall have micrometer adjustment of pointers and black phenol, black cast iron, brass, or aluminum case and ring, original rotary gear design, corrosion resistant, stainless steel movement, blowout protection, and bronze socket with wrench flats. Accuracy shall be within 1/2 of 1 percent of the scale range. They shall be as manufactured by Helicoid Gage Division, "410"; James P. Marsh Corporation, "Master Gauge"; Marshalltown; Ashcroft; U.S. Gauge; or equal.

B. All gauges shall be piped with provisions for venting pressure to allow calibration (zero) checks. Valves for gauge shutoff and zeroing shall be 1/4 turn ball valves with lever handle, corrosion-resistant.

C. Liquid filled diaphragm seals shall be installed on all gauges. Diaphragm seals shall be of the continuous duty type, 3 piece construction with 1/4 inch flushing connection, 1/4 inch fill connection, 316 stainless steel lower housing and diaphragm material 1/4 inch gauge connection and 1/2 inch lower connection. Housing bolts shall also be stainless steel. Acceptable models are Marsh 42-01, Helicoid 100H, or equal. Viton diaphragms are required on low range pressure applications (less than 15 psig). Diaphragm seals shall be "permanently" attached to gauges by installation of a lead sealed wire connecting the two. This is to prevent accidental loss of fill fluid. Fill fluid shall be factory installed silicone. All gauges shall be precalibrated, as an assembly with the seal.

2.08 PORTABLE HOIST

A. Provide a portable hoist and socket embedded in the top slab of the wet well. A cap for the socket shall be provided. The portable hoist shall be series DA as manufactured by Halliday Products Inc. of Orlando, Florida. The unit shall be sized to facilitate equipment placement and removal. The portable hoist shall be all T-304 stainless steel construction with marine grade brake winch and 30 feet (3m) of 1/4" (7mm) T-304 stainless steel cable with galvanized safety hook. The fixed reach davit arm shall be set at 24" (609mm) and the overall unit height shall be 60" (1.5m). The portable hoist shall be guaranteed against defects in material and or workmanship for a period of 3 years.

PART 3 EXECUTION

3.01 INSPECTION

A. Refer to manufacturer's instruction and installation manual before proceeding with installation of equipment.

B. Examine equipment and components for damage or loss. Inform Engineer of damage, loss, or defects. Do not proceed with installation until damage, loss or defects have been corrected.

3.02 INSTALLATION

A. Install each pumping unit in accordance with manufacturer's literature.

3.03 START-UP AND TESTING

A. See Section 01650 for general testing requirements.

B. Correct all deficiencies to satisfaction of Engineer.

3.04 FIELD QUALITY CONTROL

A. Manufacturers Field Services:
   1. Provide a factory-trained engineer for equipment installation, start-up and training in accordance with the provisions of Section 11005.
   2. The start-up engineer shall also instruct the Owner's personnel on the operation and maintenance procedures for the station.

END OF SECTION

information, pump component parts drawings, system head curves, motor data, operation and maintenance instructions, etc.

1.04 DELIVERY, STORAGE AND HANDLING

A. Unload equipment with care. In event of damage make repairs or replacements at no increase in Contract Price. Follow manufacturer's instructions for unloading equipment.

B. Store and protect equipment in strict accordance with manufacturer's written instructions.

C. See Section 01600 for general handling, storage, and protection requirements.

PART 2 PRODUCTS

2.01 DUAL COMPARTMENT SEPTIC TANK

A. The tank shall be a 1,500 gallon dual compartment septic tank. The precast concrete tank shall be constructed to the shown interior dimensions. Concrete shall have a compressive strength of 4,500 psi and be reinforced per ASTM A-615, GR 60. Joints are to be sealed with Butyl sealant per ASTM C-990.

B. All joints shall be watertight and the factory-built septic tank shall be as manufactured by Old Castle precast Cloud Concrete Products, Lexington, KY, or equal.

2.02 DISTRIBUTION BOX

A. The distribution box shall be constructed to the shown dimensions. The concrete shall have compressive strength of 4,500 psi and be reinforced with ASTM A 615-92-GR. 60 steel bars.

B. All joints shall be watertight and sealed with Butyl Sealant per ASTM C-990. The factory-built distribution box shall be as manufactured by Old Castle Precast Cloud concrete Products, Lexington, KY, or equal.

C. Adjustable weir inserts shall be provided in the entrance of each leach line exiting the distribution box.

2.03 LEACHING CHAMBERS AND END CAPS

A. The leaching chamber shall accommodate a storage capacity of 8 gallons per linear foot and have strength and physical property requirements necessary for certification in accordance with IAPMO PS-53. The chambers shall be that of the Infiltrator Systems, Inc. Quick 4 Equalizer 36 Chamber, or equal.

B. End caps shall be able to accept inlet pipes up to 4" in diameter of Schedule 40 pipe, and have 11.1 gallons of storage capacity. The factory-build end caps shall be as manufactured by Infiltrator Systems, Inc, Old Saybrook, CT, or equal.

2.04 INSPECTION PORT ASSEMBLY

A. The Quick 4 Chamber Inspection Port shall be assembled using 4" Schedule 40 PVC pipe, capped or threaded cleanout assembly, and a small meter box. The Contractor shall install the Inspector Port Assembly according to Infiltrator Systems, Inc. specifications.

B. Meter boxes shall be that of an 18-inch HDPE standard meter box. It shall be accurately centered over Inspection Port, and backfilled thoroughly, tamped about them. They shall be set vertically and properly cut and/or adjusted so that the tops of the boxes will be at finished grade.

PART 3 EXECUTION

3.01 INSPECTION

A. Refer to manufacturer's instruction and installation manual before proceeding with installation of equipment.

B. Examine equipment and components for damage or loss. Inform Engineer of damage, loss, or defects. Do not proceed with installation until damage, loss or defects have been corrected.

3.02 INSTALLATION

A. Install each item in accordance with manufacturer's literature.

END OF SECTION

SECTION 02620

SUBDRAINAGE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Building Perimeter and Retaining Wall Drainage Systems.

B. Filter aggregate and fabric and bedding.

1.02 RELATED SECTIONS

A. Section 02315 - Excavation: Excavating for subdrainage system piping and surrounding filter aggregate.

B. Section 02316 - Fill and Backfill: Backfilling over filter aggregate, up to subgrade elevation.

C. Section 02317 - Trenching for Site Utilities: Excavating and backfilling for site subdrainage systems.

1.03 REFERENCES

A. ASTM D 2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2003.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Manufacturers:
1. _____; Product ____.
2. _____; Product ____.
3. _____; Product ____.
4. Substitutions: See Section 01600 - Product Requirements.

B. Polyvinyl Chloride Pipe: ASTM D 2729; plain end, 4 inch (100 mm) inside diameter; with required fittings.

C. Use perforated pipe at subdrainage system; unperforated through sleeved walls.

2.02 AGGREGATE AND BEDDING

A. Filter Aggregate and Bedding Material: Granular fill as specified in Section 02316.

2.03 ACCESSORIES

A. Pipe Couplings: Solid plastic.

B. Filter Fabric: Water pervious type, black polyolefin. Provide _____ manufactured by _____.

C. Sleeve: _____ type for foundation wall.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that trench cut is ready to receive work and excavations, dimensions, and elevations are as indicated on layout Drawings.

3.02 PREPARATION

A. Hand trim excavations to required elevations. Correct over-excavation with _____.

B. Remove large stones or other hard matter which could damage drainage piping or impede consistent backfilling or compaction.

3.03 INSTALLATION

A. Install and join pipe and pipe fittings in accordance with pipe manufacturer's instructions.

B. Place drainage pipe on clean cut subsoil.

C. Lay pipe to slope gradients noted on shop drawings; with maximum variation from true slope of 1/8 inch (3 mm) in 10 feet (3 m).

D. Place pipe with perforations facing down. Mechanically join pipe ends.

E. Install pipe couplings.

F. Install filter aggregate at sides, over joint covers and top of pipe. Provide top cover compacted thickness of 12 inches (300 mm).

G. Place filter fabric over levelled top surface of aggregate cover prior to subsequent backfilling operations.

H. Place aggregate in maximum 4 inch (100 mm) lifts, consolidating each lift.

I. Refer to Section 02316 for compaction requirements. Do not displace or damage pipe when compacting.

J. Place impervious fill over drainage pipe aggregate cover and compact.

K. Connect to storm sewer system with unperforated pipe, through installed sleeves.

3.04 FIELD QUALITY CONTROL

A. Section 01400 - Quality Requirements: Field inspection and testing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.05 PROTECTION

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation begins.

END OF SECTION

SECTION 02630

STORM DRAINAGE

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Drainage pipe, structures and related work.

B. Related Sections:
1. Trenching: 02324.
2. Manholes: Section 02082.
3. Division 3 - Concrete.

1.02 REFERENCES

A. American Association of State Highway and Transportation Officials:

B. American Society for Testing and Materials:
1. ASTM A82, Cold-Drawn Steel Wire for Concrete Reinforcement.
2. ASTM A185, Welded Steel Wire Fabric for Concrete Reinforcement.
3. ASTM A615, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM C33, Standard Specifications for Concrete Aggregates.
5. ASTM C76, Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
6. ASTM C150, Portland Cement.
7. ASTM C443, Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
8. ASTM C478, Precast Reinforced Concrete Manhole Sections.
9. ASTM D1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
10. ASTM D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers for and other Gravity-Flow Applications.

C. National Stone, Sand & Gravel Association (NSSGA)

1.03 SUBMITTALS

A. Shop Drawings and Product Data: Furnish completely dimensioned shop drawings, layout drawings, catalog cut or other data as required to provide a complete description of piping and piping specialties.

B. Design Calculations: Submit structural calculations for all structures furnished under this section. The calculations should be sealed and signed by a Registered Professional Engineer.

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C. Certificates:
   1. Manufacturer's sworn certification that pipe will be manufactured in accordance with specified reference standards for each pipe type.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Transport, handle and store pipe materials and other products specified in a manner recommended by respective manufacturers to prevent damage and defects.

1.05 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Keep trenches dewatered until pipe joints have been made and concrete cradle and encasement, if any, have cured.
   2. Under no circumstances lay pipe in water or on bedding containing frost.
   3. Do not lay pipe when weather conditions are unsuitable, as determined by Engineer, for pipe laying work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Concrete Work Products: Formwork, Reinforcement, and Cast-In-Place Concrete per requirements of Division 3 - Concrete.

B. Riprap: Hard and angular shaped rock, free from structural defects and foreign substances such as soil, shale, and organic materials. Provide NSSGA Class Size Number as indicated on Drawings.

C. Reinforced Concrete Pipe: Class III, unless indicated otherwise on the Drawings, conforming to requirements of ASTM C76. Pipe manufactured free of honeycomb with hard, dense surface inside and outside to roughness coefficient (Kutters 'n') not exceeding 0.013.
   1. Pipe Joints: Tongue and groove or bell and spigot type.
   2. Joint Gaskets: Compression type conforming to requirements of ASTM C443.
   3. Cement Concrete: ASTM C150.
   4. Aggregate: ASTM C33.
   5. Steel Reinforcement: ASTM A82 Wire and ASTM A185 Wire Fabric.

D. High Density Polyethylene Corrugated Pipe: Provide corrugated pipe and fittings with integrally formed smooth interior, manufactured from polyethylene compounds which meet or exceed the requirements of Type III, Category 4 or 5, Graded P33 or P34, Class C according to ASTM D1248. Clean reworked material may be incorporated into the compounds.

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1. Pipe and fittings showing visible defects and foreign inclusions in the material are not acceptable.
2. Pipe lengths shall have cleanly and squarely cut ends so as not to adversely affect pipe joining.
3. Provide corrugated fittings (corrugations shall match the pipe) of either molded or fabricated type. Fittings by other than the pipe manufacturer are not acceptable.
4. Joints: Split coupling type and of a corrugated design to engage the pipe corrugations for a minimum of four corrugations, two on each side of the pipe joint.
5. Gaskets: Provide neoprene sponge gaskets on each pipe joint where pipe is installed under roadway embankments. Insert the gasket under the coupling on each side of the pipe joint.
6. Flared End Section: Provide factory fabricated end section for attachment to the HDPE corrugated pipe using a split coupling. End section shall have an integral flange or toe plate on the bottom outer edge for anchorage and to prevent undercutting.
7. Acceptable Manufacturers:
   a. Lane Enterprises, Inc.
   b. Advanced Drainage Systems, Inc.

E. End Sections (Concrete): Provide end sections of design detailed on Drawings, and conforming to forming, reinforcement and concrete materials per requirements specified in Division 3 - Concrete.

F. Trench Drain Frame and Cover: Neenah Foundry Co. Series number as indicated on Drawings.

G. Concrete Inlet: Field cast reinforced concrete type of design indicated on Drawings.
1. Forming, reinforcement and concrete materials per requirements specified in Division 3 - Concrete.
2. Frame and grating fabricated of structural steel bars and a structural steel angle frame with integral concrete anchoring lugs. Design to sustain H-20 loading per current AASHTO Specifications.

H. Precast Concrete Inlets: Provide concrete top unit with cast iron grate of design as detailed on the Drawings. Provide 4000 psi concrete conforming to Section 03300. Reinforce openings in inlet with reinforcement bars conforming to ASTM A615. Reinforce walls and bottom with welded wire fabric conforming to ASTM A185. Provide angles embedded in concrete in top of inlet to hold grate.
1. Inlet Frame and Grate: Use gratings of dimensions and design indicated on the Drawings, and fabricated of cast iron with cast angle frame. Design to sustain H-20 loading per current AASHTO Specifications.

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I. Precast Concrete Manholes: Components and materials as specified in Section 02082.
   1. Manhole Frames and Covers: As specified in Section 02082 with the following exceptions.
      a. Identification: Cast the word STORM integrally on cover in 2-inch size raised letters.

PART 3 EXECUTION

3.01 PREPARATION

A. Inspection: Prior to start of storm drainage construction, inspect each section of pipe for defects before actual use. Pipe already laid and later found defective will not be accepted.
   1. Inspect precast manhole components in accordance with requirements of ASTM C478 regarding repairable defects and defects subject to rejection by Engineer.
   2. In no instance lay pipe or set or construct manhole bases in excavations containing water or on subgrade containing frost. In all instances keep excavations water-free until concrete pours of whatever nature have cured. Keep pipe and manhole interiors cleared of debris as construction progresses.

3.02 CONSTRUCTION

A. Earthwork: Perform earthwork for buried site drainage piping and associated concrete structures as specified in Section 02324.

B. Concrete Work: Perform concrete work incidental to the Site Drainage construction as specified in Division 3 - Concrete.

C. Site Drainage Piping Installation:
   1. Following trench preparation, install Pipe Bedding and/or other types of bedding shown on the Drawings, and lay pipe proceeding up-grade true to lines and grades given.
   2. Rest each pipe section on bedding for the full length of its barrel.

D. Pipe Joining:
   1. Tongue and Groove or Bell and Spigot Joints: Install in accordance with manufacturers instructions and in accordance with ASTM C443.
   2. Laying/Joining Specified Types of Plastic Pipe: Installation and joint assembly according to ASTM D2321 requirements and for Class I bedding material as included therein.

E. Manhole Construction: Construct as specified in Section 02082.
   1. Construct reinforced concrete bases as detailed on Drawings. Concrete work to conform to Division 3 - Concrete.
   2. Terminate pipe in manhole bases flush with interior surface of base.
   3. Form concrete in bottom of manhole to guide drain water through manhole.

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4. Do not complete manhole until grading is finished and connections and tie-ins are made at proper grade and alignment.

F. Inlet Installation: Do not complete inlets until grading is finished and necessary connections and tie-ins are made at proper grade and alignment.
   1. Set precast inlet structures on a 6 inch deep compacted layer of aggregate meeting requirements of Pipe Bedding as specified in Section 02324.

END OF SECTION

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SECTION 02700

BASES, BALLASTS, PAVEMENTS, AND APPURTENANCES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Paving or surfacing of access roads and parking areas.

B. Related Sections:
   1. Trenching: Section 02324.
   2. Roadway Excavation, Backfill, and Compaction: Section 02336.

1.02 REFERENCES

A. KYTC Sections referenced below pertain only to materials, construction equipment, methods and labor. Payment provisions do not apply to work performed under this Contract.

B. Kentucky Transportation Cabinet (KYTC):
   1. Standard Specifications for Road and Bridge Construction:
      a. Section 302, Dense Graded Aggregate Base (DGA) and Crushed Stone Base (CSB).
      b. Section 403, Production and Placement of Asphalt Mixtures.
      c. Section 805, Coarse Aggregates.
      d. Section 825, De-Icers.

1.03 DEFINITIONS

A. Street: The term Street as used in this Section is understood to mean a street, highway, avenue, boulevard, road, alley, lane, driveway, parking lot, or other area used as a way for vehicles.

1.04 SUBMITTALS

A. Product Data:
   1. Submit traffic paint material manufacturer's technical information, including paint label analysis and application instructions for each material proposed.

B. Quality Assurance/Control Submittals:
   1. Design Data: Submit job mix formula for approval.
   2. Certificates: Furnish certification from bituminous and aggregate producer attesting that materials conform to requirements of Kentucky Department of Highways.

1.05 QUALITY ASSURANCE

A. Producer Qualifications:
   1. Maintain quality of work by using products of a qualified bituminous concrete producer and qualified plant operating workers.
   2. Use products of a bituminous concrete bulk producer regularly engaged in production of hot-mix, hot-laid bituminous concrete conforming to referenced standards.
   3. Use materials conforming to requirements of Kentucky Transportation Cabinet (KYTC), Standard Specifications for Road and Bridge Construction, as supplemented.

B. Workmen Qualifications:
   1. Provide at least one person thoroughly trained and experienced in skills required, readily understands design and is completely familiar with application of bituminous concrete paving work. This person is required to be present during progress of bituminous concrete paving work and direct performance of work.
   2. Employ personnel thoroughly trained and experienced in skills required for actual finishing of bituminous concrete surfaces and operation of equipment.

1.06 DELIVERY, STORAGE AND HANDLING

A. Use means necessary to ensure safe storage and use of paint materials and prompt and safe disposal of waste. Store paint products protected from weather when products may be affected by freezing.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Dust Control: Provide effective dust control by sprinkling water, by the use of calcium chloride, or by other methods as approved by the Engineer. Use dust control measures where and when, and in a manner as required by the Engineer.
   2. Weather Limitations: Terminate placement of bituminous concrete surface courses of permanent pavement between November 30 and do not resume placement prior to April 1. Interim days between date limits may be used for placement as determined by Engineer depending on weather conditions.
      a. Do not install aggregate courses when ambient temperature is below or is expected to fall below freezing.
      b. Do not use aggregate containing frost nor place aggregate courses on frozen subgrade.
      c. Do not place bituminous concrete surface courses of permanent pavement when ambient temperature is 40 degrees F. or lower, or when temperature of substrate, pavement base or binder is 40 degrees F. or lower.
   3. Paint Application Limitations: Adhere to manufacturer's data on air and surface temperature limits and relative humidity during application and curing of coatings.
      a. Do not spray apply paint when wind velocity is above 15 mph.

b. Schedule painting work to avoid dust and airborne contaminants.
c. Apply paint during daylight hours only.

B. Protection:
1. Use means necessary to protect and maintain pavement materials before, during, and after installation to protect installed work and materials of other trades.
2. In event of damage or failure of work of this Section within Guarantee Period, immediately make repairs and replacements. Failure to perform maintenance or repairs within three days after notice from Owner or Engineer, entitles Owner to perform maintenance or repairs and deduct cost from moneys due or to become due Contractor under this Contract.
3. Assume responsibility for injury or damage resulting from lack of required maintenance or repairs during Guarantee Period. Indemnify and save harmless Owner and Engineer from loss by reason of suit or action at law, based upon occurrence or omission occurring during this period.

PART 2 PRODUCTS

2.01 BASE COURSE MATERIALS

A. Subbase:
1. Crushed Stone Base conforming to KYTC Section 805.

B. Base Course: Class 1, Asphalt Base 0.75D conforming to KYTC Section 403.

2.02 SURFACE COURSE MATERIALS

A. Wearing Course: Class 1, Asphalt Surface 0.38D conforming to KYTC Section 403.

2.03 BITUMINOUS MATERIALS

A. Asphalt Binder: PG64-22 conforming to KYTC Section 806.

B. Tack Coat: SS-1, SS-1h or RS-1 conforming to KYTC Section 806.

2.04 MISCELLANEOUS MATERIALS

A. Calcium Chloride: Conforming to KYTC Section 825.

B. Traffic Paint: Zone Marking Traffic Paint as manufactured by:
1. M. A. Bruder & Sons.
2. Or Equal.

2.05 PAVEMENT MIXES

A. Composition of Mixtures: Provide wearing course mixture composition conforming to requirements of KYTC Section 403.

1. Establish a job-mix formula prior to beginning work without changing during progress of work except with Engineer's approval. Job-mixing tolerances not to permit acceptance of materials with gradations falling outside master ranges set in specified KYTC Sections.
2. Approved job-mix formula to fall within specification limits and be suitable for layer thickness and other conditions prevailing.

PART 3 EXECUTION

3.01 PREPARATION

A. Subsurface Preparation: Perform roadway grading and finish rolling just prior to subbase installation as previously specified in Section 02336.

B. Subgrade: Backfill and compact trenches in accordance with requirements of Section 02324.

C. Perform paving only after site grading, and trenching, have been completed and accepted by Engineer.

D. Moisture content of subgrade material at time of compaction is not to be more than 2 percentage points above optimum moisture content.

E. At joints between existing pavements and new paving work, cut and trim edges of existing pavements as approved by Engineer. Provide an application of Asphalt Tack Coat at locations where new paving joins existing paving.

F. Prior to traffic line painting, clean surfaces free of dirt, sand, grease or other matter.

3.02 INSTALLATION (NEW PAVING)

A. Subbase Construction: Install coarse aggregate Subbase in accordance with KYTC Section 302. Install Subbase to after compaction thickness indicated on Drawings.

B. Base Course Construction: Install Base Course in accordance with KYTC Section 403. Install Base Course to after compaction thickness indicated on Drawings.

C. Bituminous Pavement Construction: Method of preparing mixture, placing mixture, compaction, and protection of in place bituminous concrete for paving to comply with KYTC Section 403. Minimum thickness of bituminous concrete base course and wearing course is indicated on Drawings.

D. Dust Control: Provide effective dust control by sprinkling water, by use of calcium chloride or by other methods approved by Engineer. Use dust control measures where, when and in a manner required by Engineer.

3.03 APPLICATION

A. General:
   1. Strictly follow paint manufacturer's label instructions for mixing, thinning, proper spreading rate and drying time. Do not apply film thickness less than manufacturer's recommendations or exceed manufacturer's area coverage per gallon recommendations.
   2. If material has thickened or needs diluted for application, build up coating to film thickness achieved with undiluted material. Do not use thinner to extend coverage of paint.
   3. Regardless of surface, it is painter's responsibility to achieve a suitable finish by decreasing coverage rate or by applying additional coats of paint.

B. Parking Area Traffic Lines and Markings: Striping consists of white 4 inch wide painted lines of length and spacing indicated on Drawings. Paint lines accurately with sharp, clearly defined edges. Paint solid colored areas free of skips and holidays. Make linework straight and uniformly spaced.

C. Provide satisfactory barrier cones for at least 30 minutes, or until paint is dry and track free from vehicular traffic. Repaint marked or damaged areas, as directed by Engineer.

3.04 MAINTENANCE

A. Continuously maintain temporary paving without additional compensation until replaced with permanent paving.

B. Maintain without additional compensation, work of this Section for a period of twelve (12) months after date of Owner's approval of Completion Certificate issued by Engineer, including repair or removal and replacement of work that failed or has been damaged or where surface depressions have developed. Materials and methods used to repair or replace work to conform to applicable requirements of this Section.

C. Should Contractor fail to perform required maintenance or repairs within three days after written notice from Owner or Engineer, Owner may perform maintenance or repairs and deduct cost from monies due or to become due Contractor.

END OF SECTION

SECTION 02821

CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for chain link fence and gate components.

B. Related Sections:
   1. Cast-In-Place Concrete: Section 03300.

1.02 REFERENCES

A. American Society For Testing and Materials:
   1. ASTM A121, Zinc-Coated (Galvanized) Steel Barbed Wire.
   2. ASTM A392, Zinc-Coated Steel Chain-Link Fence Fabric.
   3. ASTM A824; Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   4. ASTM F567; Installation of Chain-Link Fence, Practice For.
   5. ASTM F626, Fence Fittings.
   6. ASTM F900, Industrial and Commercial Swing Gates.
   7. ASTM F1083, Pipe, Steel, Hot Dipped Zinc-coated (Galvanized) Welded, For Fence Structures.

1.03 SYSTEM DESCRIPTION

A. Design Requirements: Chain link type with top rail and bottom tension wire and single extension arms carrying three strands of barbed wire. Fabric height to 7 feet and overall height, including barbed wire extension, at 8 feet.

1.04 SUBMITTALS

A. Shop Drawings and Product Data: Manufacturer's published details modified to suit design and field conditions. Manufacturer's descriptive literature and specifications covering products specified. Include installation information.

B. Certificates: Include in Submittals certified mill certificates indicating material conformity to yield strengths of these Specifications.

1.05 QUALITY ASSURANCE

A. Fabricator Qualifications: Continuing member of Chain Link Fence Manufacturer Institute (CLFMI).

B. Erector Qualifications: Provide at least one person in a supervisory capacity, who is skilled and experienced in erecting chain link fence, readily understands proposed

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layout and is completely familiar with current erection practices of CLFMI. Said person to be present during progress of fence installation.

C. Product Compatibility: Chain link fence components to be products of one manufacturer.

PART 2 PRODUCTS

2.01 FRAME MATERIALS

A. Framing Members: Type A steel pipe (schedule 40) per ASTM F1083 having minimum yield strength of 30,000 psi. Pipe coated inside and outside by hot dipped method with minimum zinc coating of 1.8-oz/square foot.
   1. Intermediate (Line) Posts: Nominal 2-1/2 inch roll formed shapes or tubular members fabricated weighing 3.65 lbs. per ft.
   2. End, Pull and Corner Posts: Nominal 3 inch roll formed shapes or tubular members and weighing 5.79 lbs. per. ft.
   3. Gate Posts: Nominal 4 inch steel pipe or tubular members and weighing 9.l0 lbs. per ft.
   4. Post Braces: Nominal l-5/8 inch steel pipe weighing 2.27 lbs. per ft. minimum, with 3/8-inch diameter truss rod and adjustable take-up device. Provide two brace assemblies at each corner post and one brace assembly at each end and gatepost.
   5. Top Rail: Nominal 1-5/8 inch steel pipe weighing 2.27 lbs. per ft. minimum.

B. Framing Accessories: In general, conforming to ASTM F626, stretcher bars, stretcher bar bands, post tops, with zinc hot-galvanized coating.
   1. Post Tops: Where barbed wire supporting arms are not required cover post ends with pressed steel or malleable iron, weather tight caps designed to permit passage of top rail, as required.
   2. Stretcher Bars: One-piece 3/l6 x 3/4-inch bar, aluminum or galvanized steel, of length equal to full height of fabric. Provide one bar for each gate and end post and two for each corner and pull post. Provide l/2 inch wide stretcher bar bands spaced not over l5 inches O.C. to secure stretcher bars to posts.
   3. Bar Bands: Fabricated from steel plate and strip.
   4. Barbed Wire Supporting Arms: Formed steel shapes designed for three strands and of sufficient strength to withstand without failure, 250 pounds downward pull at one end of arm. Provide arms set at 45-degree angle toward outside of site.
   5. Concrete: Per requirements of Section 03300.

2.02 FABRIC AND WIRE

A. Galvanized Fabric: No. 9 gauge galvanized steel wire having a hot-dipped zinc (Class 2) coating of 2.0 ounce per square foot of wire surface. Fabric shall conform to ASTM A392.
   1. Fabric interwoven in a two-inch mesh with top and bottom selvage edges both twisted and barbed.

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B. Galvanized Barbed Wire: Three lines of steel wire with a Class 3 galvanized coating per ASTM A121. Barbed wire consists of two No. 12 1/2 gauge stranded line wires, with No. 14 gauge round wire barbs in a four-point pattern on three-inch centers.

C. Tension Wire and Tie Wires:
   1. Galvanized Tension Wire: No. 7 gauge marcelled wire conforming to ASTM A824 and galvanized according to ASTM A824 Type II zinc-coating (Class 3) at 2.0 ounces per sq. ft.
   2. Galvanized Tie Wires: Tie wire for fabric to line posts, rails, and braces; minimum 9 gauge and have the same wire and coating as tension wire.
   3. Ties: Fabric to tension wire; 9 gauge hog rings of same material as tension wire.

2.03 SWING GATE

A. Gate Frame: Fabricate in accordance with ASTM F900. Nominal 2 inch tubular horizontal and vertical members and truss members (if required) assembled by welding. Galvanize as fence frame members. Use same fabric as fence and install with stretcher bars and bar ties at 15 inches O.C. Provide diagonal cross bracing of 3/8-inch diameter adjustable length truss rods. Attach gate hardware with rivets or by other means to provide security against removal. Gate hardware as follows:
   1. Hinges: Pressed steel or malleable iron to suit gate size, non-lift-off type, and offset to permit 180 degree swing in or out. Provide one pair (top and bottom) per gate leaf.
   2. Latch: Forked or plunger bar type to permit operation either side of gate. Provide padlock eye as integral part of latch. Provide gate stops for pair of gates designed to accept drop rod or plunger bar.
   3. Keeper: Provide keeper for each gate leaf to hold gate leaf in open position until manually released.
   4. Barbed wire topping: Extend vertical members of gate frame 12 inches. Attach barbed wire to frame using tension bands to hold wire from moving out of position.
   5. Padlocks: Provide corrosion resistant brass case and brass cylinders for outdoor use, hardened steel shackle, and four pin tumbler locking mechanism. Gate padlocks keyed alike and master keyed. Provide two keys per padlock.

2.04 CANTILEVER SLIDE GATE

A. Aluminum Cantilever Slide Gate: Opening dimensions as indicated on Drawings.
   1. Gate frames made of 2-inch square aluminum tubing, alloy 6063-T6, weighing 0.94 pounds per lineal foot, welded at all corners so as to form a rigid one-piece unit. Fabric securely stretched and held on all four sides in 2 inch square tubing by use of hook bolts, 15 inches on center, and tension rods. Gate fabric is to match fence fabric.
   2. Cantilever slide gate to include a dual enclosed track consisting of a two track and rail combination aluminum extrusion, weighing 3.72 pounds per foot each with a combined weight of 7.44 pounds per foot, welded into a single top member unit. Each track to have a 2,000-pound reaction load.

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3. Provide two swivel type zinc die cast trucks, having four sealed lubricant ball bearing wheels, 2-inch in diameter by 9/16-inch in width, with two side rolling wheels to insure alignment of truck in track. Trucks held to post brackets by 7/8-inch diameter ball bolts with 1/2-inch shank. Truck assembly designed to take same reaction load as track.
4. All gate hangers, latches, brackets, guide assemblies and stop to be galvanized after fabrication from malleable iron or steel. A positive latch to be provided with provisions for padlocking.
5. Gates installed on 4-inch OD Schedule 40 galvanized posts weighing 9.1 pounds per foot. Three posts to be provided, except that dual tracks require five.
6. Guide wheel assemblies provided for each supporting post. Each assembly to consist of two rubber wheels 4-inch in diameter, attached to post so that bottom horizontal member will roll between wheels. Provide adjustability to maintain plumb gate frames and proper alignment.
7. Slide gates designed to open and close by use of a mechanical operator specified herein.

2.05 FENCE/GATE MANUFACTURERS:

A. Merchant Metals, Inc.

B. Master- Halco.

2.06 SLIDING GATE OPERATION SYSTEM:

A. Operator:
1. Motor: Provide a minimum 1 HP, 460-volt, 3 phase, high torque, and heavy-duty reversible motor, separate from the reduction mechanism for easy maintenance. Motor shall be protected against overloads and under voltage by an external overload in the control panel, which is manually reset.
2. Starter: Meet NEMA size "O" requirements with a mechanical interlock. Control circuits to be completely prewired to terminal block for ease of field installation. Include an open override design to provide complete control of the gate while closing.
3. Worm gear output speed to be reduced by #50 chain and sprockets to achieve final output speed of 36 RPM with 20:1 "C" face worm gear speed reducer.
4. Provide rotary type drive to limit travel in the open and close position. The limit switches are to be accurate and readily adjustable without the use of tools, and securely locked in place after adjustment. Switch contacts rated at 10 amps.
5. Provide a solenoid activated, disc type, adjustable locking brake.
6. Operator is to have a means of disconnect from the gate, without the use of tools, so that the gate may be operated manually in case of power failure. Disconnect to be protected by the operator cover. In manual operation a one to one drive ratio will be required to allow for fast operation.
7. Provide a #50 nickel-plated drive chain.
8. All bearings to be oil-lite brass bearings that are oil impregnated for longer life.

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9. Gate speed to be 60 feet per minute. Limit run time of the operator by an adjustable internal timer to a maximum of 90 seconds in any one direction to prevent excessive wear on integral components in the event the gate becomes obstructed during the open or close cycle.
10. Design the operator so that the reversal of the gate is delayed 1.5 seconds when signaled from any opening device so as to reduce the shock load on the operator.
11. Transformer: 70 VA rated 24V A/C secondary. Wire all control devices to the 24-volt control. Control relays to have silver cadmium oxide contacts rated at 10 amp, 120 VAC.
12. Design the operator so that any opening control device shall override the close circuit and reverse the gate to the open position.
13. Design the operator with full systems capabilities so that additional control systems may be easily added in the field.
14. Concrete pad mount the operator with the pad depth to be a minimum of 42-inches or below the local frost line. Install the operator level and mount parallel to the fence line. Test the gate to ensure that it operates freely and properly prior to the connection to the operator. The installer is to provide quarterly (3 months) preventive maintenance checks performed by factory-trained technicians during the 1-year warranty period of the system.
15. The system will be used on a single gate.
16. Gate Controls:
    a. General: Provide a keyless entry system as specified herein. All conduits for routing of wiring will be provided by the Contractor as shown on the Drawings and as necessary for a complete and satisfactory installation. Install control system with detector loops as shown on the Drawings. The inner loop at exits activates the gate to open and allows free exit when a vehicle approaches to exit. The remaining loops function to assure that the gate does not close when a vehicle is in contact with the loop area.
    b. Furnish and install inner and outer detector loops and associated timer controls at each gate entrance. Furnish cut out switch to override timer control of gate closing.
    c. Furnish and install a lockable three button "Open", "Stop", and "Close" pushbutton inside the fence in the vicinity of each operator.
17. Sliding Gate Operator Model/Manufacturers:
    a. Chamberlain Group; Liftmaster Professional, Model SL-570.
    b. Door King, Inc.; Model 920.

B. Keyless Entry System:
    1. Card Reader:
        a. Slot less touch card reader.
        b. Mounting: Pedestal mount post configuration with a weather shield to be provided.
        c. Power: 12 VAC, 20 VA transformer.
        d. Construction: Stainless steel faceplate with painted steel enclosure, gasketed for maximum weather resistance, housing-lighted.
        e. Memory Technology: EEPROM memory, non-volatile, not requiring reprogramming after a power loss.

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f. Programming: Done through the system's keypad. The programming mode is accessed through the use of a field changeable 6-digit security code.
g. Card Codes: 4 million possible codes. System shall accept up to 100 cards.
h. Time Clock: Adjusts for daylight savings time and leap year.
i. Relay Outputs: 8-amp/250 VAC entry control relay and 0.6 amp/125 VAC alarm shunt relay.
j. Y2K Compliance: All components to be Y2K compliant.
k. Anti-Pass back: Programmable from 1 to 30 minutes

2. Keyless Entry System Model/Manufacturer:
   a. ProCard Reader by Sentex
   b. Entracomp 26SA by SecuraKey.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install chain link fence in accordance with ASTM F567.

B. Do not begin prior to completion of site grading operations.

C. Drill holes for post footings in firm, undisturbed or compacted soil to a diameter equal to 4 times diameter of post. Excavate hole depths approximately 4 inches deeper than post bottom, with bottom of posts set not less than 36 inches in concrete base. Maximum spacing for posts is 10 feet on center.

D. Place concrete around posts in a continuous pour. Tamp for consolidation. Check each post for vertical and top alignment. Crown top of post footings to shed water or as detailed.

E. Set keepers, stops, sleeves and other accessories into concrete.

F. Install braces so posts are plumb when diagonal rods are under proper tension.

G. Install tension wires before stretching fabric and tie to each post with ties or clips.

H. Pull fabric taut and tie to braces, rails and tension wires with wire ties spaced not over 24 inches O.C. Leave approximately 2 inches between finished grade and bottom selvage. Install fabric on security side of fence, and anchor to framework so that fabric remains in tensions after pulling force is released.

I. Thread stretcher bars through fabric, and secure to posts with metal bands spaced not over 15 inches O.C.

J. Install 3 strands of barbed wire parallel on each extension arm on security side of fence. Pull wire taut and firmly anchor wire in the slots of the line post extension arms.

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K. Install gates plumb, level and secure for full opening without interference. Install ground set items in concrete for anchorage, as recommended by fence manufacturer and as detailed. Adjust hardware for smooth operation and lubricate where necessary.

L. Install gate operator in accordance with manufacturer's instructions and as indicated in Contract Documents.

M. Install keyless entry system/card reader in accordance with manufacturer's instructions. Owner will provide a list of cardholder's names. The system supplier shall supply cards coded to that list and program system to accept coded cards. System supplier shall also provide representative to instruct personnel on the use of the system and verify correct operation of coded cards.

END OF SECTION

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SECTION 02921

SEEDING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Seeding of work site(s).

1.02 REFERENCES

A. American Association of State Highways and Transportation Officials, AASHTO Emulsified Asphalt.

1.03 SUBMITTALS

A. Seed Certification: Submit certificates or certifying tags indicating lawn seed mixture, seed purity percentage, seed germination percentage, and weed seed content percentage to certify conformity with Specifications.

1.04 QUALITY ASSURANCE

A. Quality Control:
   1. Packaged products to indicate manufacturer's guaranteed analysis on each package and arrive on site as originally packaged and unopened.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver packaged products to site in unopened containers with labels intact and legible.

B. Store packaged products in a manner to prevent moisture damage and other forms of contamination.

1.06 PROJECT CONDITIONS

A. Environmental Requirements: Do not perform work of this Section when soil or weather conditions are unsuitable. Unsuitable conditions include moisture saturated or frozen in place soil and precipitation present or occurring during work.

B. Seeding Dates: Following dates govern except when environmental conditions warrant, Engineer may extend seeding dates.
   1. Spring: March 1 to June 1.
   2. Fall: August 1 to October 1.

C. Protection:
   1. Protect seeded areas from washouts by methods specified in this Section. Reseed washouts and bare spots that develop from inadequate protection or otherwise until a healthy, complete coverage stand of grass is obtained.
   2. Use temporary barricades to protect lawn areas from foot traffic or other areas until a healthy, total coverage stand of grass is obtained. Barricade materials subject to Engineer's approval.

D. Application seed areas disturbed by construction.
   1. Seed Mixture No. 1: Use on lawns.
   2. Seed Mixture No. 2: Use on stockpile areas.
   3. Seed Mixture No. 3: Use on slopes 3:1 and greater.
   4. Mixture No. 4: Use on wetland areas.

PART 2 PRODUCTS

2.01 LAWN AND SEED MATERIALS

A. Grass Seed: New crop seed, furnished in sealed package with proof of correct mixture evidenced, age indicated, and compliance with applicable state regulations evidenced if required. Seeds and mixture as follows:
   1. Mixture No. 1, Lawn Areas:

Species in Mix	Mix Percent by Weight	Min. Percent		Max. Percent Weed Seed
		Purity	Germination	
Red Fescue Chewings (Festuca ruaba) (Illahee strain)	30	95	85	0.50
Kentucky Bluegrass (Poa pratensis)	50	85	80	0.40
Red Top (Agrostis alba)	3	90	90	0.75
Perennial Rye Grass (Lolium perenne)	17	90	90	0.50

2. Mixture No. 2, Areas Other Than Lawns and Stockpile Areas:

Species in Mix	Mix Percent by Weight	Min. Percent		Max. Percent Weed Seed
		Purity	Germination	
Kentucky Bluegrass (Poa pratensis)	30	85	80	0.40
Perennial Rye Grass (Lolium perenne)	70	90	90	0.50

3. Mixture No. 3, Slopes 3:1 and Greater:

Species in Mix	Mix Percent by Weight	Min. Percent		Max. Percent Weed Seed
		Purity	Germination	
Crownvetch (Coronilla varia)	45	99	70*	0.10
Annual Rye (Lolium multiflorum)	55	95	90	0.15

*Minimum 40 percent normal sprouts and 30 percent hard seed.

4. Mixture No. 4, Wetland Areas:
   a. Provide seeding mixture for wetland areas consisting of herbaceous mixture of Kentucky 31 Tall Fescue, Birdsfoot Trefoil, and Red Top. Other commercially available wetland grass mixtures will be considered if submitted as a substitute.

2.02 MULCHING MATERIAL

A. Lawn Mulch: Straw Stalks of threshed grain or tall hay grass stalks free from seed bearing stalks or roots harmful to lawn growth. Mulch material containing noxious weeds, decomposed material or brittle weed material is not acceptable.

B. Mulch Binder: Emulsified asphalt conforming to requirements of AASHTO Grade RS-1 and containing no solvents of other diluting agents toxic to plant life.

PART 3 EXECUTION

3.01 PREPARATION

A. Tillage: Perform tillage of finish graded soil over areas indicated for lawn regardless of lawn work type performed. Use equipment and methods common to lawn work and till soil to a 2 inch depth minimum.

3.02 PERFORMANCE

A. Seeding: Sow seed mixtures when air current is low and not more than five days after soil supplements have been applied. Sow seeds in two applications using power seeders or mechanical seeders. Sow one half of seed mixture in one direction over designated areas and remainder at right angles to first sowing. Seeding rates as follows:
   1. Seed Mixture Nos. 1 and 2: 45 pounds per 1,000 sq. yd. areas.
   2. Seed Mixture No. 3: 9 pounds per 1,000 sq. yd. area.
   3. Seed Mixture No. 4: As recommended by manufacturer.

B. Seed Cover: Imbed seed mixtures into topsoil 1/4 inch using a light drag or rake moving in directions parallel to contour lines. Immediately after dragging or raking, compact seeded areas using a cultipacker or similar design lawn roller, weighing 60 to 90 pounds per linear foot of roller. Roll at right angles to existing slopes.

C. Contractor Option: Seeding and soil supplement application may be performed by the hydroseeding method. However, rates of application, methods, and equipment require Engineer's prior approval.

D. Lawn Mulching: Evenly apply mulch over seeded areas not more than 48 hours after seeding. Start mulching at windward side of relatively flat areas, or upper part of slopes. Spread mulch in a total coverage to a depth not less than 1-1/2 inches nor more than 3 inches.

E. Mulch Binding: Immediately following mulch spreading, apply mulch binder to anchor mulch to soil. Do not exceed three passes of binder for securing mulch with maximum applied binder not exceeding 10.0 gallons per 1,000 square feet.

F. Contractor Option: Secure mulch by peg and string method in lieu of mulch binding. Drive stakes into ground on 3 foot centers or less and string binder twine between adjacent stakes in straight lines and criss-crossed diagonally over mulch. After twine is attached, drive stakes nearly flush to ground to draw twine down tight onto mulch.

3.03 MAINTENANCE

A. Begin maintenance operations immediately after seeding and planting is performed and continue throughout construction time and guarantee period. In general, maintenance includes weeding, applying mulch as needed, controlling insects and diseases, grass cutting, and performing other particular operations as follows:
   1. Seeded Areas: Keep seed moist continually for proper germination and maintain watering to prevent drying out or burning. Reseed areas not showing a prompt catch of grass. Correct depressions and irregularities and reseed. Repeat until a complete coverage is obtained. Cut seeded areas at required intervals to maintain a maximum height of 2-1/2 inches.

B. At conclusion of maintenance periods, Engineer will inspect seeding work to determine condition of acceptance. Make additional repairs and replacements as required by Engineer at no additional expense to Owner.

END OF SECTION

SECTION 03100

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Drawings and in these Specifications.

1.02 REFERENCES:

A. American Concrete Institute:
   1. ACI 347, Guide to Formwork for Concrete.
   2. ACI 350R, Environmental Engineering Concrete Structures.

B. U.S. Department of Commerce Product Standards:
   1. PS-1-74, Construction and Industrial Plywood.
   2. PS-20-70, American Softwood Lumber.

C. Western Wood Products Association: WWPA Catalog "A" Product Use Manual.

D. American Plywood Association: APA Grade - Trademarks.

E. Southern Pine Inspection Bureau (SPIB): Standard Grading Rules for Southern Pine.

1.03 SUBMITTALS

A. Form Coating: Submit manufacturer's descriptive product data and current specification covering named product, include certification that material is acceptable for use in structures processing or storing potable water.

B. Form Ties: Submit manufacturer's descriptive product data, current specification covering named product and two samples.

1.04 QUALITY ASSURANCE

A. Formwork Design: Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.
   1. Design formwork in accordance with American Concrete Institute's Guide to Formwork for Concrete, ACI 347, and in accordance with the following:
      a. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, temporary construction material, foundation pressures, stresses, lateral stability, and such other factors pertinent to safety of structure during construction.
      b. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent construction.

B. Allowable Tolerances: Set and maintain concrete forms within tolerance limits stated in American Concrete Institute's Guide to Formwork for Concrete, ACI 347.

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Protect formwork materials before, during and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.
   2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract Price.

PART 2 PRODUCTS

2.01 MATERIALS

A. Lumber:
   1. Form framing, sheathing, struts, braces and shoring in conformance with WWPA Catalog A or SPIB Grading Rules.
   2. Rough Structural and Dimension Lumber: Provide lumber of allowable species, surfaced four sides as applicable, and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS-20-70.
   3. Use lumber free of material defects that would deform the finished concrete product.

B. Plywood:
   1. Form Sheathing and Panels: Not less than 5/8 inch thick Exterior Type B-B Plywood Class I and II EXT-APA conforming to U.S. Product Standard PS-1-74.
   2. Use Class II only on surfaces not exposed to view.

C. Steel:
   1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Drawings, may be used in lieu of wood forms.

D. Form Ties:
   1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties conforming to ACI 347 and ACI 350R.
   2. Use snap-off metal ties with ends that break at least 1½ inches from the face of the wall.
   3. Do not use removable ties that leave holes larger than one (1) inch.
   4. In construction of liquid-retaining structures and structures designed to exclude groundwater, use ties that are designed to prevent seepage or flow of water along the embedded item.
   5. Do not use removable type form ties in construction of liquid-retaining concrete structures.
   6. Do not use wire ties, flat bands or form ties fabricated on the project site.
   7. Do not use wood spacers.

E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. On surfaces which will be in contact with potable water, use no material which will add taste, odor, or toxic effects to the water.

PART 3 EXECUTION

3.01 INSPECTION

A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.02 PREPARATION

A. Apply form coatings in accordance with manufacturer's specifications.

B. Do not allow excess form coating material to accumulate in the forms.

C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.03 ERECTION

A. General: Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight, and paste tight where appearance is important.
   1. Securely brace and shore forms to prevent displacement, bowing and pillowing, and to safely support imposed concrete load.
   2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
   3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
   4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.
   5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items, and such other embedded items as indicated on Drawings.
   6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.
   7. Do not use stay-in-place metal forms.

B. Openings: Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete.

1. Securely brace temporary openings and set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in as inconspicuous a location as possible consistent with the requirements of the work.
2. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through forms. Accurately place and securely support items to be built into forms.

C. Earth Forms: Earth forms are not permitted.

3.04 CONSTRUCTION

A. Form Removal
1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
   a. Do not cut form ties back from the face of the concrete.
   b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. The Engineer's consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.
3. When the atmospheric temperature at the site has been continuously above 50 degrees F. from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph, and wet curing shall continue without delay.
   a. Forms for walls and other vertical faces may be carefully removed 24 hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal, and provided these members are not subjected to loads for a period of 14 days.
   b. Maintain horizontal forms in place for a minimum of 14 days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 p.s.i.
   c. Carefully remove forms for columns before the falsework is removed from beneath the beams or girders.
   d. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.
4. When the atmospheric temperature at the site drops below 50 degrees F., leave all forms in place for at least 5 days regardless of the temperature within the protective covering or enclosure.
5. Upon removal of forms, notify the Engineer in order that a review of the newly stripped surfaces may be made before patching.

3.05 RE-USE OF FORMS

A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.

B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.02 RELATED WORK

1. Cast-In-Place Concrete: Section 03300.

1.03 REFERENCES

A. American Concrete Institute:
   1. ACI 315; Details and Detailing of Concrete Reinforcement.
   2. ACI 318-02; Building Code Requirements for Reinforced Concrete.

B. American Society for Testing and Materials.
   1. ASTM A 82; Specification for Cold-Drawn Steel Wire for Concrete Reinforcement.
   2. ASTM A 185; Specification for smooth Welded Steel Wire Fabric for Concrete Reinforcement.
   3. ASTM A 615; Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement, including Supplementary Requirements.
   4. ASTM A 663; Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.

C. Concrete Reinforcing Steel Institute: CRSI, Manual of Standard Practice for Reinforcing Concrete Construction.

1.04 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Prepare shop drawings of concrete reinforcement in accordance with American Concrete Institute's ACI 315.
   2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing and accessories.

B. Test Reports:
   1. Submit copies of reports showing the results of tests, conducted in accordance with the American Society for Testing and Materials Specifications.
   2. Test Requirements may be waived, based upon certified copies of mill test reports.

1.05 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
   1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease and other bond-breaking coatings.
   2. Identify bundles of reinforcing steel with tags wired to steel.

1.06 PROJECT CONDITIONS

A. Protection: Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Steel:
   1. Reinforcement Bars: ASTM A615, Grade 60, deformed steel, which shall satisfy the exceptions in ACI Building Code, AASHTO and Federal Specifications.
   2. Wire: ASTM A82.
   3. Welded Wire Fabric: ASTM A185.
   4. Metal Accessories: CRSI Manual of Standard Practice for Reinforcing Concrete Construction.

B. Rebar Splicing Coupler: A two-piece splicing system manufactured from ASTM A615 Grade 60 deformed rebar. A dowel bar splicer with integral nailing flange shall be threaded for a threaded down-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.
   1. Internal Coupler Protector: Provide coupler manufacturer's plastic internal coupler protector where couplers are provided for anticipated future additions.
   2. Bar End Protectors: Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination and rust.
   3. Use Rebar Splicing Coupler only where shown on Drawings or where approved by the Engineer.
   4. Acceptable Manufacturers:
      a. Richmond Screw Anchor Co.
      b. Dayton Superior.

C. Dowel Bars (for shear transfer)
   1. Plain round bar conforming to requirements of ASTM A663, Grade 70, 75 or 80 which is not burred, roughened or deformed out-of-round so slippage is not hindered.
   2. Coat with curing compound to render surface bondless.
      a. Curing compound: Section 03300.

2.02 FABRICATION

A. General: Fabricate reinforcement to the dimensions indicated on the Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.
   1. Do not use bars with kinks or bends not indicated on Drawings.
   2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.
   3. Use a designed bending machine, either hand- or power-operated.
   4. Do not field bend bars partially embedded in concrete unless approved by the Engineer.

PART 3 EXECUTION

3.01 INSPECTION

A. Notify Engineer 48 hours before placing concrete so he can inspect placement of metal reinforcement.

3.02 INSTALLATION

A. Placing:
   1. Place metal reinforcement accurately and securely brace against displacement within permitted tolerances and in accordance with ACI 318 through the use of reinforcing accessories.
   2. Terminate reinforcement two inches from face of expansion joints.
   3. Continue reinforcement across or through construction joints.
   4. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcing around it. Do not bend the reinforcing to clear the obstructions.
   5. Install welded wire fabric as indicated, lapping joints eight inches and wiring securely. Extend welded wire fabric to within two inches of sides and ends of slabs.
   6. Do not lay metal reinforcement on formwork.
   7. Place slab reinforcement supported from the ground on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of concrete being placed. Use concrete blocks not larger than 3 inches by 3 inches with a height equal to required bottom steel cover.
   8. Reinforcement supported from formwork for slabs and beams not exposed to weather or to a continuous wet environment may use bar chairs made of plastic or metal. Use stainless steel boosters in areas exposed to a wet environment.
   9. Place additional reinforcement around openings in slabs and walls as detailed on the Drawings.

B. Splicing:

1. Splice metal reinforcement as indicated on the Drawings and in accordance with ACI 318.
2. Welding of crossing bars (tack welding) is not permitted.
3. Secure metal reinforcement at intersections with not less than No. 16-gauge annealed wire or appropriate size clips. When bar spacing is less than 12 inches, tie alternate intersections.
4. Make mechanical butt splices in accordance with rebar splicing coupler manufacturer's installation instructions.

C. Dowel Bar Installation: Install one-half the length of coated bar dowel into slab to be poured.

D. Cleaning: Clean or otherwise protect metal reinforcement so that at the time concrete is placed, reinforcement is free from rust, scale or other coatings that will destroy or reduce bond.

E. Concrete Reinforcement Protection:
1. Provide protection for reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Drawings.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work specified in this Section consists of designing mix, furnishing, placing and curing Portland cement concrete, reinforced and unreinforced, as indicated.

1.02 RELATED WORK

A. Concrete Formwork: Section 03100.

B. Concrete Reinforcement: Section 03200.

C. Work Provided Under Other Contracts: Items to be embedded in concrete are as specified in the various Sections of this Contract and other Contracts for this Project. The responsibility for coordinating concrete pours with embedded items rests solely with the Contractor.

D. Work Specified Under Other Sections: Items to be embedded in concrete are as specified in the various Sections of this Contract Specification. The responsibility for coordinating concrete pours with embedded items rests solely with the Contractor.

1.03 REFERENCES

A. American Association of State Highway and Transportation Officials, AASHTO M 182 Burlap cloth made from Jute or Kenaf.

B. American Concrete Institute:
   1. ACI 117; Standard Specifications for Tolerances for Concrete Construction and Materials.
   2. ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   3. ACI 211.2; Standard Practices for Selecting Proportions for Structural Lightweight Concrete.
   4. ACI 213R; Guide for Lightweight Aggregate Concrete.
   5. ACI 301; Specifications for Structural Concrete for Buildings.
   6. ACI 304R; Guide for Measuring; Mixing, Transporting and Placing Concrete.
   7. ACI 305R; Hot Weather Concreting.
   8. ACI 306R; Cold Weather Concreting.
   9. ACI 308; Standard Practice for Curing Concrete.
   10. ACI 318; Building Code Requirements for Reinforced Concrete.
   11. ACI 350R; Environmental Engineering Concrete Structures.

C. American Society for Testing and Materials

1. ASTM C 31; Methods of Making and Curing Concrete Test Specimens in the Field.
2. ASTM C 33; Specification for Concrete Aggregates.
3. ASTM C 39; Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C 42; Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
5. ASTM C 78; Test Method Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
6. ASTM C 94; Specification for Ready-Mixed Concrete.
7. ASTM C 143; Test Method for Slump of Portland Cement Concrete.
8. ASTM C 150; Specification for Portland Cement.
9. ASTM C 156; Test Method for Water Retention By Concrete Curing Materials.
10. ASTM C 171; Specification for Sheet Materials for Curing Concrete.
11. ASTM C 172; Methods of Sampling Freshly Mixed Concrete.
12. ASTM C 173; Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
13. ASTM C 192; Method of Making and Curing Concrete Test Specimens in the Laboratory.
14. ASTM C 231; Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
15. ASTM C 260; Specification for Air-Entraining Admixtures for Concrete.
16. ASTM C 309; Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
17. ASTM C 330; Specification for Lightweight Aggregate for Structural Concrete.
18. ASTM C 494; Specification for Chemical Admixtures for Concrete.
19. ASTM D 695; Test Method for Compressive Properties of Rigid Plastics.
20. ASTM D 1751; Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
21. ASTM D 1752; Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
22. ASTM C989; Standard Specification for ground granulated blast-furnance slag for use in concrete and mortars.

D. U.S. Army Corps of Engineers Specifications:
   1. U.S. Corps of Engineers CRD-C 572 Specification for Waterstop.

E. Federal Specifications:
   1. Fed. Spec. TT-C-800A, Curing Compound, Concrete, for New and Existing Structures.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive product data and current specifications for the concrete accessories specified herein (admixtures, joint fillers, curing materials, floor hardeners, waterstops, etc.). Include installation instructions.

B. Samples: Submit samples of materials being used when requested by the Engineer including names, sources and descriptions.

C. Design Mix: Prior to production of concrete, submit for approval, on form attached at the end of this Section, all mix designs proposed for project. Include with the mix design a standard deviation analysis in accordance with ACI 301 Section 4.2 or trial mixture test data proposed in ACI 301 Section 4.2. Use materials in such proposed design mix as specified herein. Make such adjustments in the proposed design mix as directed by the Engineer. Make such adjustments at no increase in contract price.

D. Test Reports:
   1. Submit concrete test reports specified in Part 3, Field Quality Control in this Specification.

E. Certificates:
   1. Furnish the Engineer and local authorities requiring same, certificates originated by the batch mixing plant certifying ready mixed concrete, as manufactured and delivered, to be in conformance with ASTM C 94.

F. Delivery Tickets: A delivery ticket shall accompany each load of concrete from the batch plant.
   1. Tickets must be signed by the Contractor's representative, noted as to time and place of pour and kept in a record at the site. Make such records available for inspection upon request by the Engineer.
   2. Information presented on the ticket to include the tabulation covered by ASTM C 94, Section 16, as well as any additional information the local codes may require.

G. Schedule: Submit schedule showing methods, construction joint locations and sequence of pouring a minimum of 10 days prior to placing concrete.

H. Testing Agency: Submit name and qualifications of Testing Agency to Engineer for approval prior to proceeding with testing.

1.05 QUALITY ASSURANCE

A. Testing Agency: An agency regularly performing work conforming to The American Society for Testing and Materials ASTM E 329, Recommended Practice for Inspection and Testing Agencies for Concrete and Steel in Construction.

B. Source Quality Control:
   1. Laboratory Tests: Materials stated herein require advance examination or testing according to methods referenced, or as required by the Engineer.
   2. Compression Test Cylinders: For laboratory trial batches, make in accordance with American Concrete Institute ACI 301. Test to consist of three compression test cylinders for each class of concrete with one broken at seven days and two broken at 28 days; ASTM C 192 and ASTM C 39.
   3. Flexural Strength Beams: For laboratory trial batches, make in accordance with American Concrete Institute ACI 301. Test to consist of three flexural strength

beams (6 x 6 inches) for Class A concrete only, with one broken at seven days and two broken at 28 days; ASTM C 192 and ASTM C 78. Perform this test for vehicle pavement slabs only.

1.06 PROJECT CONDITIONS

A. ACI Compliance: Cast-in-place concrete work shall conform to ACI 301 except as modified by these Specifications or the Drawings.

B. Concrete Encasement of Pipes: Encase pipes under structures and buildings indicated by the Drawings to be encased in concrete for the full length of the pipe run under the structure.

C. Concrete Encasement of Conduits: Encase conduit runs as indicated and detailed on the Drawings as work of Division 16 - Electrical Sections.

D. Equipment Bases: Construct reinforced concrete bases for equipment and piping under this contract at no increase in contract price.

1.07 SEQUENCING

A. Where other construction work is relative to concrete pours, or must be supported by or embedded in concrete, those performing such related work must be given five days notice to introduce or furnish embedded items before concrete is placed.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement:
   1. Portland Cement: ASTM C 150 of the following Type:
      a. Type II, Moderate Sulfate Resistance.
   2. Only one brand and manufacturer of approved cement shall be used for exposed concrete.
   3. Cementitious material is a mixture of cement and ground granulated blast -- furnace slag (GGBFS).

B. Ground Granulated Blast –Furnace Slag (GGBFS): Conform to ASTM C989, Grade 120, NSF approved for contact with potable water.
   1. Use GGBFS at the rate of 25% (min) to 35% (max) of the total cementitious material.

C. Normalweight Concrete Aggregates: Process aggregate meeting requirements of ASTM C 33 and subject to the following limitations.
   1. Coarse Aggregate Size: Maximum size of coarse aggregate shall not exceed the following requirements but in no case larger than 1½ inches.
      a. One-fifth narrowest dimension between sides of forms within which concrete is to be cast.

b. Three-fourths of the minimum clear spacing between reinforcing bars.
c. One-third the slab thickness for unreinforced slabs.
d. Reduced aggregate concrete containing aggregate with particle size not less than 1/8 inch nor more than 1/2 inch in any dimension and a maximum of 5 percent of particles passing a No. 8 sieve (for use in metal pan stairs only).

D. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.

E. Concrete Admixtures:
1. Prohibited Admixtures: Use only non-corrosive, non-chloride admixtures.
2. Provide admixtures produced and serviced by established, reputable manufacturers and use in compliance with manufacturer's recommendations.
3. Air-Entraining Admixture: Use a product conforming to requirements of ASTM C260.
4. Water-Reducing Admixture: Use a product conforming to requirements of ASTM C494 Type A. (Use this for all concrete except where an admixture listed below is used).
   a. Acceptable Manufacturers:
      1) Eucon WR-75; The Euclid Chemical Company.
      2) Pozzolith 220N; Master Builders.
      3) Plastocrete 161; Sika Corporation.
5. Water-Reducing and Retarding Admixture: Use a product conforming to requirements of ASTM C494, Type D.
   a. Acceptable Manufacturers:
      1) Eucon Retarder-75; The Euclid Chemical Company.
      2) Pozzolith 100XR; Master Builders.
      3) Plastiment; Sika Corporation.
6. Water-Reducing, and Acceleration Admixture: Use a product conforming to requirements of ASTM C494, Types C or E. Not permitted for use in concrete for water retaining structures.
   a. Acceptable Manufacturers:
      1) Accelguard 80; The Euclid Chemical Company.
      2) Pozzutec 20; Master Builders.
      3) Plastocrete 161 FL; Sika Corporation.
7. Store admixtures in a manner to prevent contamination, evaporation, moisture penetration, or damage. Do not use products which have been stored longer than 6 months.
8. Prior to the mix design review by the Engineer, provide written conformance to the specified requirements of the admixture.

F. Preformed Expansion Joint Fillers:
1. Nonextruding and Resilient Bituminous Types (for exterior use in pavements and sidewalks only): ASTM D1751.
2. Sponge Rubber and Cork Type: ASTM D1752.
3. Self Expanding Cork Type: ASTM D1752.
4. Acceptable Manufacturers:

a. A. C. Horn.
b. W. R. Meadows, Inc.

G. Tongue and Groove Joint Material:
1. Galvanized steel, stay-in-place, keyed form, such as manufactured by Heckmann Building Products, Inc.,
2. Use only for slabs in structures that do not retain water.

H. Vinyl Waterstops: Ribbed type manufactured from virgin polyvinyl chloride plastic compound conforming to U.S. Corps of Engineers CRD-C 572.
1. 6-inch Waterstop: 6 x 3/8-inch, such as Vinylex Corporation; Cat. No. R6-38.
2. 9-inch Waterstop: 9 x 3/8-inch with center bulb of 1-inch outside diameter; such as Vinylex Corporation; Cat. No. RLB9-38.
3. Acceptable Manufacturers:
   a. Vinylex Corporation (Catalog Nos. as specified above).
   b. A. C. Horn Inc.
   c. W. R. Meadows, Inc.
4. Retrofit Waterstop: 6 x 3/8-inch with 3-3/16 inch T leg; such as Greenstreak Product No. 609.

I. Surface Applied Waterstop: A specially formulated joint sealant which swells upon contact with water. Provide waterstop packaged in continuous length coils. Material composition as follows:
1. Chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.
2. Waterstop shall have a coating formulated to inhibit initial expansion due to moisture presence in the fresh concrete.
3. Size: Dual extrusion design; 10 mm by 20 mm.
4. Waterstop shall be secured to hardened concrete with the waterstop manufacturer's standard adhesive binder.
5. Acceptable Manufacturers:
   a. Greenstreak; Hydrotite CJ.
   b. ADECA; Ultraseal.

J. Curing Materials. Use curing materials that will not stain or affect concrete finish or lessen the concrete strength and comply with the following requirements:
1. Burlap: Materials conforming to AASHTO M 182.
2. Sheet Materials: Material conforming to ASTM C 171.
3. Liquid Curing Compound.
   a. Use curing compounds which are nontoxic and free of taste, odor and complies with low V.O.C. requirements.
   b. Where a finish material is to be applied over concrete with architectural finish, provide certification by the product manufacturer stating the curing compound as non-detrimental to the bond of the finish material.
   c. Acceptable Manufacturers:
      1) L&M Cure; L&M Construction Chemicals, Inc.
      2) Masterkure 200W; Master Builders.

K. Chemical Hardener:
   1. Chemically reactive solution materials formulated to harden and densify concrete surface.
      a. Acceptable Manufacturers:
         1) Seal Hard; L&M Construction Chemicals, Inc.

L. Non-Slip (Dry-Shake) Aggregate Surfacer: Aluminum-oxide non-slip aggregate surfacer for dry shake application to fresh concrete.
   1. Acceptable Manufacturers:
      a. Sonneborn; Frictex

M. Epoxy Bonding Compound: A high-modulus, low-viscosity, moisture-insensitive epoxy adhesive having the following properties:
   1. Compressive Properties, ASTM D 695 at 28 days;
      a. Compressive Strength: 8,000 psi. min.
   2. Tensile Properties, ASTM D 638 at 14 days.
      a. Tensile Strength: 4,000 psi. min.
      b. Elongation at Break: One to three percent.
      c. Modulus of Elasticity: 3×10^5 psi.
   3. Bond Strength, ASTM C 882:
   4. Plastic concrete to hardened concrete at 14 days (moist cure): 1,700 psi. min.
   5. Mixed epoxy resin adhesive shall conform to ASTM C 881, Type II, Grade 2, Class B and C.
   6. Acceptable Manufacturers:
      a. Sika Corporation; Sikadur 32 Hi-Mod.
      b. Euclid Chemical Company; Euco Epoxy #452 MV or #620.

N. Epoxy Adhesive (for grouting dowels): A high-modulus, two-component, high strength, moisture tolerant structural epoxy:
   1. Tensile Properties, ASTM D 638.
      a. Tensile Strength: 4,000 psi. min. at 14 days.
   2. Bond Strength, ASTM C 882.
      a. Bond Strength: 2,700 psi. min. at 14 days.
   3. Shear Strength, ASTM D 732.
      a. Shear Strength: 3,500 psi. min. at 14 days.
   4. Mixed epoxy resin adhesive shall conform to ASTM C 881.
   5. Acceptable Manufacturers:
      a. Sika Corporation; Sikadur AnchorFix-4.
      b. Euclid Chemical Company, Euco #452 Cartridge Epoxy.
      c. Simpson Strong-Tie, ET Epoxy-Tie Adhesive.

2.02 MIXES

A. Selection of Proportions of Normalweight Concrete: ACI 211.1.

B. Proportions of Ingredients: Establish proportions, including water ratio on the basis of either laboratory trial mixture tests or standard deviation analysis, with the materials specified herein.
   1. Laboratory Trial Mixture Test: ACI 301, Section 4 and ACI 318, Section 5.3.
   2. Standard Deviation Analysis: ACI 301, Section 4 and ACI 318, Section 5.3.

C. Water-Cementitious Material Ratio:
   1. Class A Concrete shall have a maximum water- cementitious material ratio of 0.42.
   2. Class B Concrete shall have a maximum water- cementitious material ratio of 0.55.
   3. Proportion Class C Concrete to meet the strength requirement.

D. Slump: Proportion and produce concrete to a slump as indicated below. The slump ranges apply when vibration is used to consolidate the concrete.

	Slump, in.	
Types of Construction	Maximum*	Minimum
Reinforced foundation walls and footings	3	1
Plain footings, caissons, and substructure walls	3	1
Slabs, beams and reinforced walls	4	1
Building columns	4	1
Pavements and slabs-on-grade	3	1
Mass concrete	2	1

* May be increased 1 in. for methods of consolidation other than vibration.

1. Pumped concrete shall have a 5-inch maximum slump, measured prior to pumping.

2.03 ADMIXTURES

A. Air Entraining: Provide air-entrained concrete for each concrete pour except where indicated otherwise on the Drawings or specified herein. Total air content required as follows:

1. Maximum-size coarse aggregate, inches:	Air content percent by volume:

1½	5 ± 1
3/4 or 1	6 ± 1
3/8 or 1/2	7½ ± 1

B. Water-Reducing Admixture: Unless high temperatures occur or placing conditions dictate a change, use concrete containing a water-reducing admixture.

C. Water-Reducing and Retarding Admixture: When high temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) may be replaced with a water-reducing and retarding admixture (Type D). Notify the Engineer of such change and submit product data prior to placement of concrete.

D. Water-Reducing and Accelerating Admixture: When low temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) can be replaced with a water-reducing and accelerating admixture. Notify the Engineer of such change and submit product data prior to placement of concrete. Water-reducing and accelerating admixture (Type C and E) will not be permitted in concrete for water retaining structures.

2.04 SOURCE QUALITY CONTROL

A. General Requirement: Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
   1. Where in-ground encasement of piping is required, provide Class B concrete.
   2. Where in-ground encasement of conduit runs is required, provide Class B concrete.

B. Classes of Concrete:
   1. Class A: 4,500 psi minimum compressive strength at 28 days; 564 pounds per cubic yard minimum cementitious material content.
   2. Class B: 3,000 psi minimum compressive strength at 28 days; 517 pounds per cubic yard minimum cementitious material content.
   3. Class C: 2,000 psi minimum compressive strength at 28 days; minimum cement content per cubic yard in accordance with current ready-mix plant standard practice.

C. Specified Flexural Strength at 28 Days:
   1. Class A: 603 psi.

PART 3 EXECUTION

3.01 INSPECTION

A. Inspect work to receive cast-in-place concrete for deficiencies which would prevent proper execution of the finished work. Do not proceed with placing until such deficiencies are corrected to the satisfaction of the Engineer.

3.02 PREPARATION

A. Joints:
   1. Construction Joints: Only the location of critical joints throughout the structures are indicated on the Drawings. Select additional joint locations in walls, slabs, and beams subject to the Engineer's approval and meeting the following conditions:
      a. Locate such joints to least impair the strength of the structure and near the middle of the span of structural slabs or beams.
      b. The horizontal length between wall joints shall not exceed 30 feet in a continuous wall. At corners or other intersections of two or more walls, provide a joint in each wall at a distance less than 15 to 20 feet from the intersection point in all directions.
      c. Space construction joints in structural slabs not greater than 30 feet in each direction, although some adjustments, as approved by the Engineer, may be permitted due to column spacing and details.
      d. If a beam intersects another beam at a proposed construction joint, offset the joint in the beam a distance equal to twice the width of the beam and provide adequate shear reinforcement as determined by the Engineer.
      e. Maximum joint spacing for slabs-on-grade shall not be greater than 20 feet.
      f. Provide waterstops in construction joints where such joints are exposed to liquids, in contact with earth, or subject to weather exposure.
      g. Place walls and slabs in alternate sections allowing at least two days elapsed time for slabs and five days elapsed time for walls before concrete is placed against an adjacent joint.
      h. Submit requests for approval of joint locations ten days prior to scheduled concrete pours. Do not make concrete pours unless joint locations have been approved by the Engineer.
      i. No exceptions permitted to the above requirements unless written approval is given by the Engineer.
   2. Expansion Joints and Contraction Joints:
      a. Install where indicated on the Contract Drawings.
      b. Do not extend reinforcing or other embedded metal items through expansion and contraction joints except where indicated otherwise on Contract Drawings.
      c. Sawcutting contraction joints will not be permitted.
      d. Provide waterstops in joints exposed to liquids, in contact with earth, or subject to weather exposure.
   3. Bonding to New Concrete: Bond fresh concrete with hardened previously poured new concrete in accordance with the following:
      a. Roughen and clean hardened concrete of foreign matter and laitance and dampen with water.
      b. Cover the hardened concrete with a heavy coating of grout to approximately ½-inch thickness. Use grout of same material composition and proportions of concrete being poured except coarse aggregate omitted. Use grout with a slump of 6 inches minimum.
      c. Place new concrete on grout before it has attained its initial set.

d. Other bonding methods must be approved by Engineer prior to use.

4. Bonding to Existing Concrete: Roughen existing concrete in the area of bonding to produce exposed aggregate and an absolutely uncontaminated concrete surface.
   a. Apply Epoxy Bonding Compound over existing prepared concrete in accordance with manufacturer's instructions.
5. When concreting is to be discontinued for more than forty-five (45) minutes and if the construction plane is to be horizontal, install keyways, waterstops and embed dowels in the concrete before initial hardening. Use keyways and dowels in vertical concrete construction only when indicated or directed by the Engineer. Use waterstops for water retaining structures or structures below grade. Horizontal joints are not permitted in slabs or footings.
   a. Extend dowels placed in joint one splice length into wall and one splice length into next concrete pour.

B. Embedded Items:
   1. PVC Waterstops:
      a. Install in all joints where watertightness is required.
         1) Vinyl Waterstops:
            a) Use ribbed-type waterstops of the following dimensions except as otherwise indicated on the Contract Drawings.
               (1) Expansion joints in new construction: 9 inches wide by 3/8 inch thick, with center bulb.
               (2) Contraction and construction joints: 6 inches wide by 3/8 inch thick; no center bulb.
      b. Use continuous lengths without splices where possible.
      c. Provide factory-formed and tested waterstop corners and intersections leaving only straight butt joint splice in the field.
      d. Connect all adjoining waterstops including vertical and horizontal runs to provide a continuous water barrier.
      e. Splices:
         1) Strength: Not less than 50% of the mechanical strength of the parent section.
         2) Watertightness: Make equal to that of continuous material.
         3) Heat seal adjacent surfaces in accordance with manufacturer's recommendations using a thermostatically controlled electric source of heat that provides sufficient heat to melt but not to char the material.
      f. Adequately support waterstops to prevent displacement and deformity of the waterstops during concrete pours. Maintain two inch minimum clearance between waterstop and reinforcing steel.
      g. Center waterstop on joint with one-half of waterstop width to be embedded in concrete on each side of joint. At expansion joints, keep center bulb unembedded.
      h. In substructures and other structures required to be watertight, install waterstops if concreting is discontinued for a sufficient length of time which, in the opinion of the Engineer, may result in seepage cracks in concrete.
   2. Surface Applied Waterstop Installation: Install surface applied waterstop at such location where indicated on the Drawings.

a. Install the waterstop in strict accordance with the manufacturer's installation instructions and with respect to the environmental requirements specified therein and substrate preparation.

3. Embedded Pipes and Conduits: Material not harmful to concrete may be permitted to be embedded in concrete upon approval by the Engineer. Items embedded shall satisfy the following:
   a. Maximum outside dimension not greater than one-third the overall thickness of the member in which it is embedded.
   b. Minimum spacing between items not less than 3 widths on center nor 3 inches clear between items.
   c. Item shall not impair strength of member.
   d. Provide 2 inch minimum clearance to face of slab.

C. Anchoring Reinforcement Dowels into Existing Concrete:
   1. Drill holes for each dowel to the size and depth indicated on the Drawings with carbide tip bit or star bit. Core drilling will not be permitted. Do not drill into or cut or otherwise damage existing reinforcement bars. If existing reinforcement bars are encountered during the drilling operation, relocate the hole to clear the existing reinforcement as directed by the Engineer.
   2. Blow clean each finished hole with an oil free air jet and then flush with a jet of clean water.
   3. Immediately prior to the grouting operation, remove all water from the hole and from the walls of the hole.
   4. Pump dispensing gun for proper mixture. Insert nozzle and pump epoxy adhesive into the hole and insert reinforcement dowels. Do not retemper grout that has begun to stiffen; discard such grout.

3.03 CONSTRUCTION

A. Production of Concrete
   1. Ready-Mixed Concrete:
      a. Batched, mixed and transported in accordance with ASTM C94.
      b. Add admixtures to the mix in accordance with ACI 301.
      c. Plant equipment and facilities conforming to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.

B. Placing
   1. General: Conduct placement work in accordance with ACI 304R and such additional requirements as specified herein.
      a. Complete discharge of the concrete within 1 ½ hours or before the mixing drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.
   2. Preparation:
      a. Prepare formwork in advance and remove snow, ice, water and debris from within forms.

b. Pre-position reinforcement in advance of concrete pours.
c. Pre-position waterstops, expansion joint materials, anchors and embedded items in advance of concrete pours.
d. Sprinkle subgrades sufficiently to eliminate water loss from concrete in accordance with ACI 301 Chapter 11.
e. Do not place concrete on frozen surfaces.

3. Conveying:
   a. Handle concrete from mixer to final deposit rapidly by methods which will prevent segregation or loss of ingredients to maintain required quality of concrete.
   b. Do not convey concrete through aluminum or aluminum alloy.
   c. Do not place concrete by pumps or other similar devices without prior written approval of the Engineer.
   d. Placing concrete by pumping methods shall conform to the applicable requirements of ACI 304R, Chapter 9, and ACI 304.2R.
4. Depositing:
   a. Do not drop concrete freely where reinforcing will cause segregation, nor more than four (4) feet.
   b. Deposit concrete in approximately horizontal layers of 12 to 18 inches.
   c. Do not allow concrete to flow laterally more than three feet.
   d. Place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
   e. Do not deposit concrete on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.
   f. Do not use concrete which has partially hardened or has been contaminated by foreign materials.
   g. Do not subject concrete to procedures which will cause segregation.
   h. Do not place concrete in forms containing standing water.
   i. Make placement within sections continuously to produce monolithic unit.
   j. Do not begin placement of concrete in beams or slabs until concrete previously placed in walls or columns have attained initial set.
   k. Do not bend reinforcement out of position when placing concrete.
5. Consolidation:
   a. Consolidate concrete by vibration, spading, rodding, or other manual methods. Work concrete around reinforcement, embedded items and into corners; eliminate all air or stone pockets and other causes of honeycombing, pitting or planes of weakness.
   b. Use vibration equipment of internal type and not the type attached to forms and reinforcement.
   c. Use vibrators capable of transmitting vibration to concrete in frequencies sufficient to provide satisfactory consolidation.
   d. Do not leave vibrators in one spot long enough to cause segregation. Remove concrete segregated by vibrator operation.
   e. Do not use vibrators to spread concrete.
   f. Have sufficient reserve vibration equipment to guard against shutdown of work occasioned by failure of equipment in operation.

6. Cold Weather Concreting: Perform cold weather concrete work in accordance with ACI 306R and the following additional requirements.
   a. Provide concrete delivered at the job-site in accordance with the following temperature limitations:

Air Temperature Deg. F	Minimum Concrete Temperature, deg. F	
	For sections with least dimension less than 12 in.	For sections with least dimension 12 in. or greater
30 to 45	60	55
0 to 30	65	60

   b. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
   c. Maintain concrete at temperatures listed in Table 1.4.1 of ACI 306R as follows, after the concrete has developed a compressive strength of 500 psi:
      1) slab-on-grade: 2 days.
      2) walls and supported slabs: 3 days.
   d. If the strength is not achieved, maintain the minimum temperature an additional 24 hours or until the 500 psi strength is reached.
   e. Make additional concrete cylinders to verify strength achievement of 500 psi; however, additional cylinders are not required for every pour, provided concrete temperatures are maintained fairly uniform. Once two sets of cylinders have been broken and a strength of 500 psi is achieved, additional cylinders will not be required, except for random testing as determined by the Engineer.
   f. Remove temperature protection after 500 psi is achieved, but in a manner so thermal shock does not occur to the exposed concrete. The removal criteria shall be as stated in ACI 306R.
   g. Leave housing, covering, or other protection used in curing intact at least 24 hours after artificial heating is discontinued.
   h. Surfaces with which the concrete is to come in contact must be free of frost, snow and ice. Subgrade shall be free of frost. Do not place concrete around any embedment which has a temperature below freezing.
   i. If water or aggregate is heated above 100 degrees F, combine water with aggregate in the mixer before cement is added. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees F.
   j. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. Do not use foreign materials or materials containing snow or ice.
   k. Surfaces with which the concrete is to come in contact with must be free of frost, snow to and ice.

7. Hot Weather Concreting: Perform hot weather concrete work in accordance with ACI 305R and the following additional requirements.
   a. Temperature of concrete delivered at the job-site shall not exceed 90 degrees F.
   b. Cool ingredients before mixing to prevent temperature in excess of 90 degrees F.
   c. Make provisions for windbreaks, shading, fog spraying, sprinkling or wet cover when necessary.
8. Underwater Concreting: In general, perform underwater concreting work in accordance with ACI 304R Chapter 8 and the following requirements:
   a. When permitted by Engineer, foundation concrete may be placed in still water.
   b. Concrete placed in water shall contain an additional twenty percent of cement above the amount specified for the particular class of concrete used. No additional compensation will be allowed for this added cement.
   c. Do not deposit concrete in water which has a temperature below 40 degrees F.
   d. Place the concrete underwater continuously through a tremie pipe. Diameter of the tremie pipe shall be approximately eight times the maximum size of the largest coarse aggregate. Use seal in pipe to start concrete placement, and keep filled with concrete continuously with the end of the pipe embedded in the placed concrete at all times. If seal is lost, withdraw pipe and reseal and start charging operations again.
   e. Protect placed concrete from water motion for at least four days and longer if required.

C. Finishing:
   1. General: Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material.
   2. Formed Surfaces: Provide one or more of the following finishes to the surfaces of the concrete after removal of forms. The locations where these finishes are required are listed herein or specified on the Drawings. Allowable surface irregularities are designed as either "abrupt" or "gradual." Check gradual irregularities using 10 foot straightedges.
      a. "Rough Form" finish: Surface may include roughness and irregularities not to exceed ½ inch, but tie holes and defects shall be patched.
      b. "Ordinary Wall" finish: Surface that is true and uniform without any conspicuous offsets or bulges. Gradual irregularities not to exceed ½ inch and abrupt irregularities not to exceed 1/4 inch.
      c. "Plywood" finish: Similar to the ordinary wall finish. Construct the surface of the forms using 5/8-inch plywood or boards lined with tempered hardboard not less than 3/16 inch thick. Place the plywood or liner sheets in an orderly and symmetrical arrangement using sheets as large as practicable. Do not use sheets showing torn grain, worn edges, patches of holes from previous use, or other defects which will impair the texture of the concrete surfaces. Remove gradual irregularities exceeding ½ inch and abrupt irregularities exceeding

1/8 inch. Completely remove all fins on the surface. Rub all surfaces which cannot meet these requirements.

d. "Rubbed" finish: Apply to a freshly hardened "plywood" finish. Complete rubbing within one day of removal of forms. Wet surfaces and rub with a carborundum brick or other abrasive until all form marks, projections, and irregularities have been removed and a smooth uniform surface, texture, and color are produced. Wash the surface clean after rubbing.

3. Unformed Surfaces: In concrete having unformed surfaces, use just sufficient mortar to avoid the necessity for excessive floating. Slope exposed unformed surfaces to provide quick, positive drainage and to avoid puddles in low spots. Unless otherwise noted, set floor drains 1/2 inch below the normal floor elevation and slope floor toward the drain. Slope all surfaces exposed to weather 1/4 inch per foot for drainage unless noted otherwise on Drawings.

   a. "Floated" Finish: After concrete has been placed, consolidated, struck off and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after first floating, check planeness of surface with a ten foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots during this procedure to produce a surface with true planes within 1/4 inch in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction. Following straightedge checking, refloat slab immediately to a uniform sandy texture.

   b. "Steel Trowel" Finish: Obtained by working a floated finish with a steel trowel. First troweling shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings by hand after the surface has hardened sufficiently. Perform final troweling when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate surface by hand trowel operations. Produce finished surface essentially free of trowel marks, uniform in texture and appearance, with true planes within 1/4 inch in ten feet, as determined by a ten foot straightedge placed anywhere on the slab in any direction.

   c. "Broom or Belt" Finish: Immediately after concrete has received a floated finish, give surface a coarse transverse scored texture by drawing a broom or burlap across the surface.

   d. "Nonslip" Finish: The surfaces shall be given a "dry shake" application of non-slip aggregate surfacer. The rate of application of such material not to be less than 25 pounds per 100 square feet. Apply in accordance with manufacturer's recommendations.

4. Special Finishes:

   a. Weirs and Overflow Surfaces: Provide "hard steel trowel" finish to surfaces to produce a hard, dense, smooth, surface free of irregularities. Obtain finish by trowelling a regular steel trowel finish after the surface has nearly hardened. The hard surface will have a somewhat glossy appearance. The elevation of the weir crest shall be constant along its entire length.

b. Flumes and Troughs: Provide a "hard steel trowel" finish to the top of bottom slab. Use "plywood" formed finish on side walls, and an "ordinary wall" finish on overhead surfaces. Provide a "rubbed" finish on all surfaces which will not be in contact with water.
c. Deck Finish: Power or single hand trowelling of slab surface followed by a light hair broom drawn across the slab to produce fine shallow scored texture.
d. Architectural Finishes. Special finishes such as Vinyl Composition Tile, Quarry Tile, Ceramic Tile, or other, when used, shall be as specified herein or on the Drawings.

5. Application for Finishes: Except where the type of finish is indicated on the drawings or under "Special Finish", all concrete surfaces shall be finished as indicated below.
   a. "Rough Form" Finish:
      1) All surfaces to be covered by earth and not exposed to view.
   b. "Ordinary Wall" Finish:
      1) Interior and exterior wall and slab surfaces not exposed to view.
      2) Inside vertical surfaces of tank type structures below an elevation which is 18 inches below normal water surface.
      3) Interior walls of filters below an elevation which is 6 inches below the filter media.
      4) All wall and overhead surfaces.
      5) Undersides of slabs which will be covered by architectural ceilings.
   c. "Plywood" Finish:
      1) All surfaces to be painted.
   d. "Rubbed" Finish:
      1) All interior and exterior surfaces exposed to view which are not to be painted.
      2) All exterior surfaces to a point 6 inches below finished ground.
      3) Inside vertical surfaces of tank type structures above an elevation which is 18 inches below normal water surface.
      4) Interior walls of filters to a point 6 inches below filter media.
      5) Equipment pads, pipe supports, etc.
   e. "Floated" Finish:
      1) All unformed surfaces unless otherwise specified.
   f. "Steel Trowel" Finish:
      1) Interior floors of structures except where Architectural Finish is to be applied.
      2) Interior stair treads.
      3) Tops of exposed walls.
      4) Floors of basins.
   g. "Broom or Belt" Finish:
      1) Sidewalks, exterior ramps and platforms.
      2) Unloading dock platform.
      3) Walkways on the process tanks.
   h. "Nonslip" Finish:
      1) Exterior stair treads and landings.

i. Architectural Finishes:
   1) As specifically called for in these Specifications or on the Drawings.

6. Application of Chemical Hardener: Apply to floor surfaces as scheduled on Drawings. Concrete must be a minimum of twenty-eight (28) days old and cured by water or sheet material curing methods.
   a. Concrete surfaces must be clean, dry and free of residues, oil, wax, sealers, curing compounds, laitance or other contaminants in order to promote maximum penetration of hardener.
   b. Apply hardener in two applications in accordance with hardener manufacturer's instructions and by such methods as stated in instructions.
   c. Application: Mechanical scrubbers, equipped with brushes are the preferred method of application for the first coat.
   d. Pour chemical hardener directly from the container onto the surface to be treated, maintaining an application rate of 200 $ft.^2$ per gallon. Scrub chemical hardener into the surface for 15-20 minutes, working all areas evenly.
   e. Apply second coat using sprayers or rollers in accordance with manufacturer's instructions.

3.04 CURING AND PROTECTION

A. General: Immediately after placement and finishing, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Perform curing by either water curing, sheet form curing or liquid membrane forming methods in accordance with ACI 308. Cure concrete continuously for a minimum of seven days at ambient temperatures above 40 degrees F.

B. Hot Weather Curing: See Hot Weather Concreting this Section.

C. Cold Weather Curing: See Cold Weather Concreting this Section.

D. Application of Liquid Curing Compound:
   1. Finishing operations must be completed prior to application. Apply compound as soon as the free water on the surface disappears and no water sheen is visible. Surface shall be capable of taking walking workmen without being marred. Apply compound in two (2) applications.
   2. Do not apply curing compound to construction joint surfaces. Protect exposed reinforcement during application of curing compound. Water cure those areas not coated with compound.
   3. Do not use liquid curing compound when the ambient air temperature during placement and for 24 hours after placement is or will fall below 35 degrees F.
   4. Do not use liquid curing compounds on concrete surfaces which will receive later treatments, such as hardeners, special finishes, protective coating, dampproofing, waterproofing, future grout, grout fill, or coatings.

E. Curing of surfaces to receive Membrane Waterproofing shall be controlled by water fog spraying, water damped coverings, and/or impermeable sheet film cover for the full 7-day period specified above. All concrete surfaces shall have a minimum cure of

28 days before application of the membrane. The use of liquid membrane-forming curing compounds on these surfaces is prohibited.

F. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.05 FIELD QUALITY CONTROL

A. Testing and Inspection:
   1. During the entire period when concrete is being placed, provide testing services by an independent testing laboratory at no cost to the Owner.
   2. The Engineer reserves the right to make any and all tests as he deems necessary during the progress of the work.
   3. Failure of the independent testing laboratory or the Engineer to detect defective work will not prevent rejection when defect is later discovered, nor will it obligate the Engineer for final acceptance.
   4. The Independent Testing Laboratory shall:
      a. Obtain composite samples in accordance with ASTM C172.
      b. Mold and cure three test specimens for each strength test in accordance with ASTM C 31 and as follows:
         1) Concrete compression test: Use standard 6 inch x 12 inch cylinders.
         2) Concrete flexural strength: Use 6 inch x 6 inch x 12 inch beams.
         3) Identify each test by number, mix, amount of admixture, origin of sample in the structure, the date the test specimen was made, the date the test specimen was tested, the amount of slump determined, and the compressive and flexural strength test results.
         4) Test Methods:
            a) Compressive strength test: ASTM C39.
            b) Flexural strength test: ASTM C78 ((Required only for slabs-on-grade subject to wheel loads)).
            c) Test one specimen at 7 days for information and test two specimens at 28 days for acceptance. A strength test is the average of the strengths of the two cylinders tested at 28 days.
            d) Perform one strength test for each 50 cu. yds. of concrete poured, unless waived by the Engineer, but not less than one test for each structure.
      c. Make slump tests for each truck load upon truck arrival at the job-site and whenever consistency of concrete appears to vary in accordance with ASTM C 143.
      d. Make air content tests for each truck load upon truck arrival at the job-site in accordance with ASTM C231 or ASTM C173.
      e. Prepare and submit all reports required in the various standards and specifications referenced herein.
         1) Distribution of reports shall be:
            a) Two copies to the Engineer.
            b) One or more copies, as required, to the Contractor.

f. Immediately notify the Contractor and the Engineer of any test results which do not conform to the Specification requirements.

B. Evaluation and Acceptance:
   1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength tests equal or exceed specified strength and no individual strength test result is below specified strength by more than 500 psi.
   2. If the concrete fails to meet the specified strength requirements the Engineer may require one or both of the following:
      a. The Engineer shall have the right to order a change in the mix proportions for the remaining concrete being poured.
      b. The Engineer may order tests on the in-place concrete. Testing shall be in accordance with ACI 301 at no increase in contract price.

3.06 REPAIR OF DEFECTIVE CONCRETE

A. Defective Concrete
   1. Porous areas, open or porous construction joints and honeycombed concrete will be considered to indicate that the requirements for mixing, placing and handling have not been complied with and will be sufficient cause for rejection of the members of the structure thus affected.
   2. Defective work exposed upon removal of forms shall be entirely removed or repaired within forty-eight hours after forms have been removed.
   3. Repaired areas will not be accepted if:
      a. The structural requirements have been impaired by reducing the net section of compression members.
      b. The bond between the steel and concrete has been reduced.
      c. The area is not finished to conform in every respect to the texture, contour, and color of the surrounding concrete.
   4. If the above requirements are not satisfied or if there are excessive honeycombs or other defects, the Engineer may require that the members of unit involved be entirely removed and satisfactorily replaced at no additional expense to the Owner.
   5. The Engineer will determine the extent and manner of action to be taken for the correction of defective concrete as may be revealed by surface defects or otherwise.
      a. Prior to repair of structural defects or defects which impair watertightness (shrinkage cracks, etc.), submit proposed material and repair methods to the Engineer for approval.
   6. As soon as the forms have been stripped and the concrete surfaces exposed, remove fins and other projections, fill recesses left by the removal of form ties, and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete to the satisfaction of the Engineer.

7. Hammer pack tie holes and other small cavities with a stiff mortar of the same material, but somewhat leaner than that in the concrete. Clean the cavity and the area wetted before mortar is placed.
8. Repair and patch defective areas with cement mortar of mix proportions and materials identical to those used in the surrounding concrete. Produce a finish on the patch that is indistinguishable from the surrounding concrete.
9. Where the honeycomb or voids are not excessive and repairs are authorized by the Engineer, chip out the defective areas in a square shape to sound solid concrete with a depth not less than 2 inches. Make edges of cuts perpendicular to concrete surface or slightly undercut to provide a key at the edge of the patch. Before placing cement mortar, thoroughly clean, dampen and brush coat area to be patched with neat cement grout. Other patching materials may be used if accepted by Engineer in writing prior to start of repair work. The patch should be kept damp for seven days at a temperature above 50°F.

END OF SECTION

FINAL CONCRETE MIX DESIGN SUBMITTAL FORM

(One for each required mix design)

PROJECT: _____ Location: ___
General Contractor:___
Mix design no.: _____ Design strength: ____

USE (Describe *): ___
Mix Design Preparation: (check one) Based on Standard Deviation Analysis: _____
or Based on Trial Mixture Test Data: _____

MATERIALS:

Aggregates: (Provide size, type, source, specification)
Coarse: _
Fine: ___

Cement Type/Source: ___

Admixtures: (Provide product, manufacturer)
Water Reducer: _
Air Entraining: _
Accelerator: ____
Other: _

CONCRETE PROPERTIES

Water/Cementitious Material Ratio: _____
Slump: _____ inches
Entrained Air: ____ %
Density _____ pcf

SPECIFIC GRAVITIES

Fine Aggregate _____
Coarse Aggregate: _____

ADMIXTURES

Accelerator _____ oz. per 100# cement
W. R. _____ oz. per 100# cement
A. E. _____ oz. per 100# cement
Other _____ oz. per 100# cement

MIX PROPORTIONS

	Weight (lbs)	Absolute Volume (cubic feet)
Cementitious Material: _____	_____	
Fine ** Aggregate:	_____	_____
Coarse ** Aggregate:	_____	_____
Water:	_____	_____
Entrained Air:	_____	_____
Other:	_____	_____
TOTAL:	_____	_____

TEST RESULTS SUBMITTAL FORM

METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318-95 ¶ 5.3.2.1):

Number of Test Cylinders Evaluated: _ Standard Deviation: _____
(Attach Copy of All Test Results)

Mix Designs Proportioned to Achieve Both of the Following:

$f'_{cr} = f'_c + 1.34s =$ _____ psi
$f'_{cr} = f'_c + 2.33s - 500 =$ _____ psi

Actual $f'_c =$ _____ psi (f'_{cr})

Slump = _____ in. Air Content = _____ %

METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318-95 ¶ 5.3.2.2):

Age (days)	Mix 1 (comp. str.)	Mix 2 (comp. str.)	Mix 3 (comp. str.)
7	_____	_____	_____
28	_____	_____	_____
28	_____	_____	_____
28 day avg.	_____	_____	_____

Mix Design Proportioned to Achieve the Following:

$f'_{cr} = f'_c + 1200$ psi (for f'c 5000 psi)
or $f'_{cr} = f'_c + 1400$ psi (for f'c > 5000 psi)

Slump = _____ in. Air Content = _____ %

REMARKS:_____

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable). See Design and Control of Concrete Mixtures, Portland Cement Association, for assistance in filling out this form.

SUBMITTED BY:
Ready-Mix Supplier: Name _____
Address: _____
Phone Number: _____

SECTION 03415

PRECAST CONCRETE HOLLOW CORE PLANKS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Precast floor and roof planks.

B. Connection plates with brackets and hangers.

C. Grouting plank joint keys.

1.02 RELATED SECTIONS

A. Section 03300 - Cast-in-Place Concrete.

1.03 REFERENCES

A. ACI 301 - Specifications for Structural Concrete for Buildings; American Concrete Institute International; 2005.

B. ACI 318 - Building Code Requirements for Structural Concrete and Commentary; American Concrete Institute International; 2005.

C. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2005.

D. ASTM A 416/A 416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete; 2005.

E. ASTM A 615/A 615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement; 2006.

F. AWS B2.1 - Specification for Welding Procedure and Performance Qualification; American Welding Society; 2005.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006.

H. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel; American Welding Society; 2005.

I. PCI MNL-116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products; Precast/Prestressed Concrete Institute; 1999, Fourth Edition.

J. PCI MNL-120 - PCI Design Handbook - Precast and Prestressed Concrete; Precast/Prestressed Concrete Institute; Sixth Edition, 2004.

K. PCI MNL-123 - Design and Typical Details of Connections for Precast and Prestressed Concrete; Precast/Prestressed Concrete Institute; 1988, Second Edition.

L. PCI MNL-124 - Design for Fire Resistance of Precast Prestressed Concrete; Precast/Prestressed Concrete Institute; 1989, Second Edition.

M. PCI MNL-126 - Manual For The Design of Hollow Core Slabs; Precast/Prestressed Concrete Institute; 1998.

N. PCI MNL-135 - Tolerance Manual For Precast and Prestressed Concrete Construction; Precast/Prestressed Concrete Institute; 2000.

1.04 DESIGN REQUIREMENTS

A. Design planks in accordance with the requirements of PCI MNL-120, PCI MNL 126, PCI MNL-124, ACI 318, and ACI 301.

B. Design connections in accordance with PCI MNL-123.

C. Design components to withstand dead loads and design loads in the configuration indicated on the drawings and as follows:
   1. Roof Assembly: 30 lb/sq ft (____ kPa) live load.
   2. Maximum Allowable Deflection of Roof Planks: 1/180 span, cambered to achieve slope to drain.
   3. Design components to accommodate construction tolerances, deflection of other building structural members and clearances of intended openings.
   4. Grouted Keys: Capable of transmitting horizontal shear force of 2,000 lb/ft (3,000 kg/m).

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Indicate standard component configuration, design loads, deflections, and cambers.

C. Shop Drawings: Indicate plank locations, unit identification marks, connection details, edge conditions, bearing requirements, support conditions, dimensions, openings, openings intended to be field cut, and relationship to adjacent materials.

D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and _____.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed in Lexington, KY.

B. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

C. Erector Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

D. Welder Qualifications: Qualified within previous 12 months in accordance with AWS B2.1.

1.07 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

B. Discuss anchor and weld plate locations, sleeve locations, and cautions regarding cutting or core drilling.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.

B. Mark each member with date of production and final position in structure.

1.09 PROJECT CONDITIONS

A. Coordinate with framing components directly associated with the work of this section.

B. Coordinate field cut openings with affected section.

C. Coordinate location of hanger tabs and devices for mechanical and electrical work.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Precast Concrete Hollow Core Planks:
1. Licensee of Span-Deck, Inc., SPAN-DECK Units
2. Substitutions: Not permitted.

2.02 MATERIALS

A. Concrete Materials: As specified in Section 03300.

B. Tensioning Steel Tendons: ASTM A 416/A 416M, Grade 250 (1725); seven-wire stranded steel cable; low-relaxation type; full length without splices; uncoated.

C. Reinforcing Steel: ASTM A 615/A 615M Grade 60 (420) deformed steel bars.

D. Non-Shrink Grout: Non-metallic, minimum compressive strength of 10,000 psi (69 MPa) at 28 days.

E. Cement Grout: Minimum compressive strength of 3,000 psi (21 MPa) at 28 days.

2.03 ACCESSORIES

A. Connecting and Supporting Devices: Plates, angles, items cast into concrete, items connected to steel framing members, and inserts: ASTM A 36/A 36M carbon steel; prime painted.

B. Core Hole End Plugs: Cardboard insert with stiff concrete fill.

C. Hanger Tabs: Galvanized steel, designed to fit into grouted key joints, capable of supporting 500 lbs (225 Kg) dead load, predrilled to receive hanger.

D. Bearing Pads: High density plastic, 1/8 inch (3 mm) thick, smooth on one side. Vulcanized elastomeric compound molded to size.

2.04 FABRICATION

A. Planks: Plant cast, prestressed, hollow core.
   1. Dimensions as indicated on drawings.
   2. Nominal thickness: 8 inches (____ mm); nominal width: 48 inches (____ mm).

B. Weld reinforcing in accordance with AWS D1.4.

C. Embed anchors, inserts, plates, angles, and other items at locations indicated.

D. Provide openings required by other sections, at locations indicated.

E. Cut exposed ends flush.

F. Plant Finish: Finish members to PCI MNL-116 Commercial Grade.

G. Connecting and Supporting Steel Devices: Do not paint surfaces in contact with concrete or surfaces requiring field welding.

2.05 FABRICATION TOLERANCES

A. Conform to PCI MNL-116 and PCI MNL-135.

2.06 SOURCE QUALITY CONTROL AND TESTS

A. See Section 03300 for testing of concrete and grout, materials, and mix designs.

B. Produce planks in accordance with requirements of PCI MNL-116. Maintain plant records and quality control program during production of precast planks. Make records available upon request.
   1. Maintain one copy on project site.

C. Inspect and test stressing tendons before delivery for compliance with specified standards.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that site conditions are ready to receive work and field measurements are as indicated on shop drawings.

3.02 PREPARATION

A. Prepare support devices for the erection procedure and temporary bracing.

3.03 ERECTION

A. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.

B. Install bearing pads at bearing ends of planks.

C. Align and maintain uniform horizontal and end joints, as erection progresses.

D. Maintain temporary bracing in place until final connection is made. Protect members from staining.

E. Adjust differential camber between precast members to tolerance before final attachment and grouting.

F. Adjust differential elevation between precast members to tolerance before final attachment.

G. Install hanger tabs in joints at 4 inches (____ mm) on center.

H. Secure units in place. Perform welding in accordance with AWS D1.1.

I. Grout longitudinal keys as indicated.

J. Make plank-to-plank joints smooth using grout, troweled smooth. Transition differential elevation of adjoining planks with grout to a maximum slope of 1:12.

3.04 ERECTION TOLERANCES

A. Erect members level and plumb within allowable tolerances. Conform to PCI MNL-135, except as specifically amended below.
   1. Top Elevation from Building Elevation Datum at Plank Ends: Plus or minus 1/2 inch (12.5 mm).
   2. Maximum Jog in Alignment of Matching Ends: Plus or minus 1/2 inch (12.5 mm).
   3. Differential Top Elevation As Erected: Plus or minus 3/8 inch (9 mm).

3.05 PROTECTION OF FINISHED WORK

A. Protect members from damage caused by field welding or erection operations.

B. Provide non-combustible shields during welding operations.

3.06 CLEANING

A. Clean weld marks, dirt, and blemishes from surface of exposed members.

END OF SECTION

SECTION 03600

GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This section covers the furnishing and placing of grout as specified on the drawings and in various other sections of these specifications.

1.02 RELATED SECTIONS

A. Cast-In-Place Concrete: Section 03300.

1.03 REFERENCES

A. American Concrete Institute:
   1. ACI 308, Recommended Practice for Curing Concrete.
   2. ACI 530-92, Building Code Requirements for Masonry Structures.

B. American Society for Testing and Materials:
   1. ASTM C33, Concrete Aggregates.
   2. ASTM C150, Portland Cement.
   3. ASTM C404, Aggregates for Masonry Grout.
   4. ASTM C596, Drying Shrinkage of Mortar Containing Portland Cement, Measuring.
   5. ASTM C827, Early Volume Change of Cementitious Mixtures.
   6. ASTM C1019, Standard Method of Sampling and Testing Grout.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive product data and current specifications covering named manufactured products specified in this Section. Include placing instructions. Submit product data for the following:
   1. Non-Shrink Non-Metallic Grout.
   2. Non-Shrink Metallic Grout.

B. Design Mix (for Grout Swept in by Mechanism): Prior to production of this grout, submit for approval a design mix indicating materials proportions and water-cement ratio. Use materials in the proposed design mix as specified herein. Make such adjustments in the proposed design mix as directed by the Engineer. Make such adjustments at no increase in Contract Price.

1.05 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Furnish the grout manufacturer's current independent laboratory test results indicating the grout as non-shrink from time of placement as conforming to the following:
   1. Indicating no expansion after final set, according to ASTM C 827.
   2. Indicating 4,000 psi strength developed with a trowelable mix within 24 hours, according to ASTM C 109.
   3. Indicating placement time based on initial set of not less than 60 minutes, according to ASTM C 191.

B. Qualifying Test Results: Furnish from the grout manufacturer, test results indicating that in projects of similar scope and size, the effective bearing area was between 95 and 100 percent.

1.06 DELIVERY, STORAGE AND HANDLING

A. Prevent moisture damage and contamination of materials.

B. Store materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.07 PROJECT CONDITIONS

A. Protect against high and low temperatures and bad weather in accordance with American Concrete Institute standards for placement of concrete.

PART 2 PRODUCTS

2.01 MATERIALS

A. Grout (Sand/Cement); For Process Areas: Provide sand/cement grout composed of the following components:
   1. Portland Cement: ASTM C 150, Type II (Sulfate Resistant) cement.
   2. Sand: ASTM C 33, fine aggregate.
   3. Aggregate: Provide reduced size aggregate (for Grout Swept in by Process Mechanism) conforming to AASHTO No. 8 size and meeting material quality requirements of ASTM C 33.

B. Water: Potable quality, free from deleterious amounts of acids, alkalis, and organic substances.

C. Non-Shrink Metallic Grout: Use ready-mix product such as Sonneborn Ferrolith G Redi-Mixed, Master Builders Embeco 153 Grout, W. R. Grace & Co. Vibro-Foil, Ferrogrout by L & M Construction Chemicals.

D. Non-Shrink Non-Metallic Grout: Factory premixed material containing no corrosive irons, aluminums, chemicals, or gypsums.

1. Grouts containing water reducers, accelerators, or fluidifiers shall have no drying shrinkage greater than the equivalent sand cement and water mix as tested per ASTM C596.
2. Grout shall be nonshrink before initial set and show no expansion after set as tested per ASTM C827.
3. Initial set of grout not less than 60 minutes per ASTM C191 Test.
4. Use Type I (Normal) cement in grout formulation.
5. Acceptable Manufacturer:
   a. Five Star Products, Inc., Five Star Grout
   b. Sonneborn
   c. Master Builders
   d. L & M Construction Chemicals

E. Neat Cement:
   1. Portland Cement: ASTM C150 Type I.
   2. Water: As specified above.

2.02 MIXES

A. Non-Shrink Grout: Use ready-mix type requiring only the addition of water. Do not add other materials. Water requirement proportions shall conform to manufacturer's specifications for the desired mix consistency.

B. Neat Cement: Mixture of Portland Cement and water in the same proportions used in cast-in-place concrete Class A with fine aggregate and coarse aggregate omitted.

PART 3 EXECUTION

3.01 PREPARATION

A. Preparation of Surface:
   1. Normal Grout: Clean areas to be grouted free of oil, grease, laitance, dirt and other contaminants. Remove loose material. Remove rust, paint, and oil from metal components in contact with grout.
   2. Non-Shrink Grout: Prepare in accordance with manufacturer's printed instructions.

B. Forming:
   1. Use forming procedures that allow proper and complete placement of grout.
   2. Anchor support elements so no movement is possible.
   3. Remove supports only after grout has hardened.
   4. Pre-treat wood forms that may absorb moisture with forming oils.

C. Grout Mixing: Use power-operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.
   1. Mix Non-Shrink Grout in accordance with manufacturer's instructions.
   2. Mix Grout (Sand/Cement) in accordance with requirements specified for concrete under Section 03300.

3.02 INSTALLATION

A. Grout (Sand/Cement) Swept In By Mechanism: Grout indicated on the Drawings to be Swept In By Mechanism shall not be placed until the equipment mechanism is installed and ready for operation.
   1. Following surface preparation, saturate the concrete with water. Remove excess water and brush on a coat of Neat Cement. Place Grout while Neat Cement is wet.
   2. Place Grout in a single pour, starting at the center and working out towards the tank walls. As placing proceeds, slowly operate equipment mechanism striking off the Grout by means of screeds attached to equipment mechanism bottom and so adjusted to provide the proper depth. Use care in filling depressions and removing excess Grout in front of screed blades.
   3. After screeding, straight-edge Grout surface for trueness and consolidate and finish with a wood float.
   4. Score joints at the tank walls to the full depth of the Grout. Sawing of joints after Grout curing is not allowed.
   5. Cure Grout by wet burlap or inundation in accordance with ACI 308. Curing with sealers not permitted.
   6. After curing fill scored joints with joint sealer.

B. Grout (Sand/Cement): For grouting applications other than swept in by mechanism, place and cure Grout as follows:
   1. Following surface preparation, saturate the concrete with water; then remove excess water and brush on a coat of Neat Cement. Place grout while Neat Cement is wet.
   2. Place Grout in a single pour. Straight-edge exposed Grout surface for trueness, consolidate and finish with a steel trowel.
   3. Cure and seal in accordance with ACI 308.
   4. In vertical applications, place Grout in monolithic pours.

C. Non-Shrink Metallic Grout: Place in unexposed areas or exposed areas where grouting or equipment is subject to heavy vibratory forces. Place in accordance with manufacturer's instructions.

D. Non-Shrink Non-Metallic Grout: Perform grout placement in accordance with the recommendations of ACI and the manufacturer's published specification for mixing and placing. Place non-shrink non-metallic grout only where indicated on Drawings.

END OF SECTION

SECTION 04065

MORTAR AND MASONRY GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Mortar for masonry.

B. Grout for masonry.

1.02 RELATED SECTIONS

A. Section 04810 - Unit Masonry Assemblies: Installation of mortar and grout.

B. Section 08110 - Steel Doors and Frames: Grouting steel door frames installed in masonry.

1.03 REFERENCES

A. ACI 530/ASCE 5/TMS 402 - Building Code Requirements For Masonry Structures; American Concrete Institute International; 2005.

B. ACI 530.1/ASCE 6/TMS 602 - Specification for Masonry Structures; American Concrete Institute International; 2005.

C. ASTM C 94/C 94M - Standard Specification for Ready-Mixed Concrete; 2005.

D. ASTM C 144 - Standard Specification for Aggregate for Masonry Mortar; 2004.

E. ASTM C 150 - Standard Specification for Portland Cement; 2005.

F. ASTM C 207 - Standard Specification for Hydrated Lime for Masonry Purposes; 2006.

G. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2005a.

H. ASTM C 404 - Standard Specification for Aggregates for Masonry Grout; 2004.

I. ASTM C 476 - Standard Specification for Grout for Masonry; 2002.

J. ASTM C 595 - Standard Specification for Blended Hydraulic Cements; 2005.

K. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2006.

L. ASTM C 979 - Standard Specification for Pigments for Integrally Colored Concrete; 2005.

M. ASTM C 1019 - Standard Test Method for Sampling and Testing Grout; 2005.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C 270 is to be used. Also include required environmental conditions and admixture limitations.

C. Samples: Submit two samples of mortar, illustrating mortar color and color range.

D. Reports: Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C 270 and test and evaluation reports per ASTM C 780.

E. Reports: Submit reports on grout indicating conformance of component grout materials to requirements of ASTM C 476 and test and evaluation reports to requirements of ASTM C 1019.

F. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

G. Manufacturer's Instructions: Submit packaged dry mortar manufacturer's installation instructions.

1.05 QUALITY ASSURANCE

A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.
   1. Maintain one copy of each document on project site.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Portland Cement: ASTM C 150, Type I - Normal; color as required to produce approved color sample. Provide _____ manufactured by _____.

B. Blended Cement: ASTM C 595, Type S; color as required to produce approved color sample. Provide _____ manufactured by _____.

C. Hydrated Lime: ASTM C 207, Type S.

D. Mortar Aggregate: ASTM C 144.

E. Grout Aggregate: ASTM C 404.

F. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C 979.
   1. Color(s): As selected by Architect from manufacturer's full range.
   2. Manufacturers:
      a. Davis Colors; Product ____: www.daviscolors.com.
      b. Lambert Corporation; Product ____: www.lambertusa.com.
      c. Solomon Colors; Product ____: www.solomoncolors.com.
      d. Substitutions: See Section 01600 - Product Requirements.

G. Water: Clean and potable.

H. Moisture-Resistant Admixture: Water repellent compound designed to reduce capillarity.
   1. Acceptable product:: "DRY-BLOCK" by Forrer Industries, "SGS Block-Ade" by Solomon Grind-Chem, Inc., or "Rheomix Rheopol" by Master Builders, Inc...
   2. Substitutions: See Section 01600 - Product Requirements.

2.02 MORTAR MIXES

A. Mortar for Unit Masonry: ASTM C 270, Property Specification.
   1. Masonry below grade and in contact with earth: Type S.
   2. Exterior, loadbearing and non-loadbearing masonry: Type N.
   3. Exterior, veneer masonry: Type N.
   4. Interior, loadbearing and non-loadbearing masonry: Type N.
   5. Pointing mortar: Type N with maximum 2 percent ammonium stearate or calcium stearate per cement weight.

B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

2.03 MORTAR MIXING

A. Thoroughly mix mortar ingredients using mechanical batch mixer, in accordance with ASTM C 270 and in quantities needed for immediate use.

B. Maintain sand uniformly damp immediately before the mixing process.

C. Add mortar color in accordance with manufacturer's instructions. Provide uniformity of mix and coloration.

D. Do not use anti-freeze compounds to lower the freezing point of mortar.

E. If water is lost by evaporation, re-temper only within two hours of mixing.

F. Use mortar within two hours after mixing at temperatures of 90 degrees F (32 degrees C), or two-and-one-half hours at temperatures under 40 degrees F (5 degrees C).

2.04 GROUT MIXES

A. Bond Beams, Lintels, and vertical application in masonry walls: 2500 psi (____ MPa) strength at 28 days; 8-10 inches (200-250 mm) slump; provide premixed type in accordance with ASTM C 94/C 94M.
   1. Fine grout for spaces with smallest horizontal dimension of 2 inches (50 mm) or less.
   2. Coarse grout for spaces with smallest horizontal dimension greater than 2 inches (50 mm).

2.05 GROUT MIXING

A. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C 476 for fine and coarse grout.

B. Do not use anti-freeze compounds to lower the freezing point of grout.

2.06 PRECONSTRUCTION TESTING

A. Grout Mixes: Test grout batches in accordance with ASTM C 1019 procedures.
   1. Test results will be used to establish optimum grout proportions and establish quality control values for construction testing.

PART 3 EXECUTION

3.01 PREPARATION

A. Plug clean-out holes for grouted masonry with brick masonry units. Brace masonry to resist wet grout pressure.

3.02 INSTALLATION

A. Install mortar and grout to requirements of section(s) in which masonry is specified.

B. Do not install grout in lifts greater than 12 inches (300 mm) without consolidating grout by mechanical vibration during placement and reconsolidate after initial water loss has occurred and before plasticity is lost.

C. Do not displace reinforcement while placing grout.

D. Remove excess mortar from grout spaces.

3.03 GROUTING

A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.

B. Low-Lift Grouting:
   1. Limit height of pours to 12 inches (300 mm).
   2. Limit height of masonry to 16 inches (400 mm) above each pour.
   3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
   4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1 hour. If grout placement is stopped for 1 hour or longer, a horizontal construction joint shall be formed 1 inch below top of block except at top of wall.

C. High-Lift Grouting:
   1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
   2. Hollow Masonry: Limit lifts to maximum 4 feet (1.2 m) and pours to maximum height of 24 feet (7.3 m).
   3. Place grout for spanning elements in single, continuous pour.

3.04 FIELD QUALITY CONTROL

A. Test and evaluate grout in accordance with ASTM C 1019 procedures.

1. Test frequency: Take one sample for each 25 cubic yards of grout, or fraction thereof, being placed each day.

END OF SECTION

SECTION 04810

UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Concrete Block.

B. Slate.

C. Reinforcement and Anchorage.

D. Flashings.

E. Accessories.

1.02 RELATED SECTIONS

A. Section 03200 - Concrete Reinforcement: Reinforcing steel for grouted masonry.

B. Section 03415 - Precast Concrete Hollow Core Planks.

C. Section 04065 - Mortar and Masonry Grout.

D. Section 05500 - Metal Fabrications: Loose steel lintels.

E. Section 06100 - Rough Carpentry: Nailing strips built into masonry.

F. Section 07540 - Thermoplastic Membrane Roofing: TPO parapet flashing.

G. Section 07620 - Sheet Metal Flashing and Trim: Masonry drips, counter flashings and reglets.

H. Section 07710 - Manufactured Roof Specialties: Copings.

I. Section 07840 - Firestopping: Firestopping at penetrations of masonry work.

J. Section 07900 - Joint Sealers: Backing rod and sealant at control and expansion joints.

1.03 REFERENCES

A. ACI 530/ASCE 5/TMS 402 - Building Code Requirements for Masonry Structures; American Concrete Institute International; 2005.

B. ACI 530.1/ASCE 6/TMS 602 - Specification For Masonry Structures; American Concrete Institute International; 2005.

C. ASTM A 82/A 82M - Standard Specification for Steel Wire, Plain, for Concrete Reinforcement; 2005a.

D. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.

E. ASTM A 641/A 641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire; 2003.

F. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.

G. ASTM C 90 - Standard Specification for Loadbearing Concrete Masonry Units; 2006.

H. ASTM C 129 - Standard Specification for Nonloadbearing Concrete Masonry Units; 2005.

I. ASTM C 140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units and Related Units; 2005a.

J. ASTM C 270 - Standard Specification for Mortar for Unit Masonry; 2005a.

K. ASTM C 744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units; 2005.

L. ASTM C 780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry; 2006.

M. ASTM D 1970 - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection; 2001.

N. UL (FRD) - Fire Resistance Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.

C. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Comply with provisions of ACI 530/ASCE 5/TMS 402 and ACI 530.1/ASCE 6/TMS 602, except where exceeded by requirements of the contract documents.
   1. Maintain one copy of each document on project site.

B. Fire Rated Assemblies (1 Hour Rating): Conform to applicable code for UL Assembly No. ____.

C. Fire Rated Assemblies (2 Hour Rating): Conform to applicable code for UL Assembly No. ____.

1.06 MOCK-UP

A. Construct a masonry wall as a mock-up panel sized 8 feet (2.4 m) long by 6 feet (1.8 m) high, which includes mortar and accessories and structural backup.

B. Locate where directed.

C. Mock-up may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Cold and Hot Weather Requirements: Comply with requirements of ACI 530.1/ASCE 6/TMS 602 or applicable building code, whichever is more stringent.

1.10 EXTRA MATERIALS

A. See Section 01600 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 CONCRETE MASONRY UNITS

A. Concrete Block: Comply with referenced standards and as follows:
   1. Size: Standard units with nominal face dimensions of 16 x 8 inches (400 x 200 mm) and nominal depths as indicated on the drawings for specific locations.
   2. Special Shapes: Provide non-standard blocks configured for corners, lintels, control joint edges, and other detailed conditions.
   3. Load-Bearing Units: ASTM C 90, normal weight.
      a. Hollow block, as indicated.
      b. Exposed faces: Special color and texture where indicated, as follows:

      _____.
   4. Non-Loadbearing Units: ASTM C 129.
      a. Hollow block, as indicated.
      b. Normal weight.

B. Concrete Masonry Insulating Units: Specially designed concrete masonry units and individually molded insulation inserts combined at the block manufacturing plant.
   1. Block manufacturers:
      a. Beavertown Block Co., Inc: www.beavertownblock.com.
      b. Nitterhouse Concrete Products: www.nitterhouse.com.
      c. York Building Products Co.: www.yorkbuilding.com.
      d. New Holland Concrete.www.newhollandconcrete.com
      e. Substitutions: See section 01600 - Product requirements.
   2. Size: Standard units with nominal face dimensions of 16 x 8 inches (400 x 200 mm) and nominal depths as indicated on the drawings for specific locations.
   3. Special Shapes: Provide non-standard blocks configured for corners, lintels, control joint edges, and other detailed conditions.
   4. Load-Bearing Units: ASTM C 90, normal weight.
      a. Hollow block, as indicated.
      b. Exposed faces: Manufacturer's standard color and texture where indicated on the elevations and wall sections.

5. Non-Loadbearing Units: ASTM C 129.
   a. Hollow block, as indicated.
   b. Normal weight.
6. Manufacture units with integral polymeric water-repellant admixture such as:
   a. Grace Masonry Products: Dry - Block.
   b. Solomon Grind - Chem Service, Inc.: SGS Block - Ade.
   c. Master Builders Inc.: Rheomix Rheopol.
   d. Substitutions: See Section 01600 - Product Requirements.
7. Insulation units: Molded, expanded polystyrene as manufactured by:
   a. Concrete Block Insulating Systems; Product Korfil Hi-R: www.cbisinc.com/hir.html
   b. Substitutions: See section 01600 - Product requirements.
8. Manufacture units with minimum insulation values for the Hi-R Wall System alone, using block made with 100 #/cf concrete, as follows:
   a. 12 - inch Korfil Hi-R CMIU: Provide minimum calculated R value of 12.48.
   b. 10 - inch Korfil Hi-R CMIU: Provide minimum calculated R value of 11.87.
   c. 8 - inch Korfil Hi-R CMIU: Provide minimum calculated R value of 10.27.

C. Sound Absorptive Concrete Masonry Units: Specially designed concrete masonry units with a cavity-slot resonator design and a metal septum and/or a fibrous filler in selected units.
1. Manufacturers as licensed by The Proudfoot Company, Inc of Monroe, CT under the Soundblox name:
   a. Beavertown Block Co., Inc: www.beavertownblock.com.
   b. Nitterhouse Concrete Products: www.nitterhouse.com.
   c. York Building Products Co.: www.yorkbuilding.com.
   d. New Holland Concrete.www.newhollandconcrete.com
   e. Substitutions: See section 01600 - Product requirements.
2. Size: Standard units with nominal face dimensions of 16 x 8 inches (400 x 200 mm) and nominal depths as indicated on the drawings for specific locations.
3. Non-Loadbearing Units: ASTM C 129.
   a. Hollow block, as indicated.
   b. Normal weight.
4. Manufacture units with an NRC rating for average sound absorption coefficient values from 125 - 5000 Hertz frequency, when painted, as follows:
   a. 4 - inch type RSC: Provide units with an NRC rating of 0.80.

2.02 SLATE

A. Slate Window Sills: Natural stone slate conforming to ASTM C629, Type I, free from spalls, pits, cracks or other defects and of clear stock with honed finish.
1. Color: Range selected with submittal approval.

2.03 MORTAR AND GROUT MATERIALS

A. Mortar and grout: As specified in Section 04065.

2.04 REINFORCEMENT AND ANCHORAGE

A. Manufacturers of Joint Reinforcement and Anchors:
   1. Dur-O-Wal: www.dur-o-wal.com.
   2. Hohmann & Barnard, Inc: www.h-b.com.
   3. Masonry Reinforcing Corporation of America: www.wirebond.com.
   4. Substitutions: See Section 01600 - Product Requirements.

B. Reinforcing Steel: Type specified in Section 03200; size as indicated on drawings; galvanized finish.

C. Single Wythe Joint Reinforcement: Ladder type; ASTM A 82/A 82M steel wire, mill galvanized to ASTM A 641/A 641M, Class 3; 0.1875 inch (4.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage on each exposure.

D. Adjustable Multiple Wythe Joint Reinforcement: Ladder type with adjustable tabs spaced at 16 in (406 mm) on center and fabricated with moisture drip; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/153M, Class B; 0.1875 inch (4.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods and adjustable components of 0.1875 inch (4.8 mm) wire; width of components as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage from each masonry face.
   1. Vertical adjustment: Not less than 2 inches (50 mm).

E. Flexible Anchors: 2-piece anchors that permit differential movement between masonry and building frame, sized to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage from masonry face.
   1. Concrete frame: Dovetail anchors of bent steel strap, nominal 1 inch (25 mm) width x 0.024 in (0.61 mm) thick, with trapezoidal wire ties 0.1875 inch (4.75 mm) thick, hot dip galvanized to ASTM A 153/A 153M, Class B.
   2. Steel frame: Crimped wire anchors for welding to frame, 0.25 inch (6.3 mm) thick, with trapezoidal wire ties 0.1875 inch (4.75 mm) thick, hot dip galvanized to ASTM A 153/A 153M, Class B.

F. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch (4.8 mm) thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in (32 mm).

2.05 FLASHINGS

A. Rubberized Asphalt Thru-Wall Flashing: Self-adhering polymer-modified asphalt sheet complying with ASTM D 1970; minimum 0.040 inch (1.0 mm) total thickness; with cross-linked polyethylene top and bottom surfaces.
   1. Manufacturers:
      a. Grace Construction Products; Product Perm-A-Barrier.
      b. Carlisle Coatings & Waterproofing.
      c. Hohmann & Barnard.
      d. Substitutions: See Section 01600 - Product Requirements.

B. For cavity walls, build inner wythe ahead of outer wythe to accommodate accessories.

C. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

3.07 REINFORCEMENT AND ANCHORAGE - GENERAL

A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches (400 mm) on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches (150 mm).

E. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches (400 mm) on center.

F. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 36 inches (900 mm) horizontally and 24 inches (600 mm) vertically.

3.08 REINFORCEMENT AND ANCHORAGE - SINGLE WYTHE MASONRY

A. Install horizontal joint reinforcement 16 inches (400 mm) on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches (150 mm).

E. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches (400 mm) on center.

3.09 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

A. Install horizontal joint reinforcement 16 inches (400 mm) on center.

B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches (400 mm) each side of opening.

C. Place continuous joint reinforcement in first and second joint below top of walls.

D. Lap joint reinforcement ends minimum 6 inches (150 mm).

E. Masonry Back-Up: Embed anchors to bond veneer at maximum 16 inches (400 mm) on center vertically and 36 inches (900 mm) on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches (200 mm) on center.

F. Reinforce stack bonded unit joint corners and intersections with strap anchors 16 inches (400 mm) on center.

3.10 MASONRY FLASHINGS

A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
   1. Extend flashings full width at such interruptions and at least 4 inches (100 mm) into adjacent masonry or turn up at least 4 inches (100 mm) to form watertight pan at non-masonry construction.
   2. Remove or cover protrusions or sharp edges that could puncture flashings.
   3. Seal lapped ends and penetrations of flashing before covering with mortar.

B. Extend metal flashings through exterior face of masonry and turn down to form drip. Install joint sealer below drip edge to prevent moisture migration under flashing.

C. Extend plastic, laminated, and EPDM flashings to within 1/4 inch (6 mm) of exterior face of masonry.

D. Lap end joints of flashings at least 4 inches (100 mm) and seal watertight with mastic or elastic sealant.

3.11 LINTELS

A. Install loose steel lintels over openings.

B. Install reinforced unit masonry lintels over openings where steel or precast concrete lintels are not scheduled.
   1. Openings to 42 inches (1070 mm): Place two, No. 3 (M9) reinforcing bars 1 inch (25 mm) from bottom web.
   2. Openings from 42 inches (1070 mm) to 78 inches (1980 mm): Place two, No. 5 (M16) reinforcing bars 1 inch (25 mm) from bottom web.
   3. Openings over 78 inches (1980 mm): Reinforce openings as detailed.
   4. Do not splice reinforcing bars.
   5. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch (13 mm) of dimensioned position.
   6. Place and consolidate grout fill without displacing reinforcing.
   7. Allow masonry lintels to attain specified strength before removing temporary supports.

C. Maintain minimum 8 inch (400 mm) bearing on each side of opening.

3.12 GROUTED COMPONENTS

A. Reinforce bond beams with 2, No. 5 (M16) bars, 1 inch (25 mm) from bottom web.

B. Lap splices minimum 24 bar diameters.

C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch (13 mm) of dimensioned position.

D. Place and consolidate grout fill without displacing reinforcing.

10. ASTM B 633, Specification for Electro deposited Coatings of Zinc on Iron and Steel.
11. ASTM F 436, Specification for Hardened Steel Washers.
12. ASTM F 959, Specification for Compressible-Washer-Type Direct Tension Indicators for use with Structural Fasteners.

D. American Welding Society (AWS): D1.1 Structural Welding Code - Steel.

1.04 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Submit shop drawings, prepared under the supervision of and sealed by a licensed structural engineer, identifying the details as indicated on Drawings, indicating completely its location in the project, the size and weights of members, the methods of joining various components, the quantity, finish, the location and type of anchors and necessary measurements.
   2. For shop assemblies which require markings for erection identification, provide easy-to-read markings on shop and erection drawings.
   3. Note on shop drawings variations in tolerances or clearances between various products.
   4. Use standard welding symbols of the American Welding Society on shop drawings.

B. Working Drawings:
   1. Furnish setting diagrams, templates, and directions for the installation of structural framing anchor bolts, bearing plates, and other embedded items.

C. Welding Records and Data:
   1. Prior to commencing work requiring welding, submit the procedure which will be used for prequalifying welders and welding procedures. For all procedures other than those set forth in AWS D1.1, submit a copy of procedure qualification test records.
   2. Submit certified copy of qualification test record for each welder, welding operator, and tacker who will be employed in the work.
   3. Submit certified copy of reports for all analyses and tests required by referenced ASTM Specifications, including test reports for filler metals for welding, and mechanical tests for high-strength threaded fasteners and shear connectors.

D. Mill Test Results
   1. Submit reports signed by the manufacturer certifying their products comply with requirements specified.
   2. Submit test reports certifying material conforms to ASTM specifications.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Fabricator: Company experienced in fabricating structural steel similar to that indicated for the project who has a successful in-service performance for a minimum of 5 continuous years and sufficient production capacity.
   a. Fabricator must participate in the AISC Quality Certification Program and designated an AISC Certified Plant with Category II ranking, complex steel building structures.
2. Erector: Company experienced in erecting structural steel work similar to that indicated for the project who has a successful in-service performance with a minimum of 5 continuous years of experience.
3. Welder, Tacker and Welding Operator Qualifications: Use welders, tackers and welding operators who have been previously qualified by tests as prescribed in the Structural Welding Code, AWS D1.1 of the American Welding Society, to perform type of work required.

B. Comply with applicable provisions listed in those references stated in Article 1.02 of this specification unless otherwise indicated.

1.06 DELIVERY, STORAGE AND HANDLING

A. Store steel on platforms, skids, blocking or other supports to prevent dirt and debris contact. Protect from exposure to conditions that produce rust.

B. Handle steel so no parts are bent, broken or otherwise damaged and avoid damage to other material and work. Store beams with webs vertical. Exercise care to avoid scraping and over stressing the steelwork.

C. Mark weight on all members. Match-mark all shop pre-fitted members.

D. Ship small parts, such as bolts, nuts, washers, pins, fillers, and small connecting plates and anchors, in boxes, crates, or barrels. Pack separately each length and diameter of bolt and each size of nut and washer. Plainly mark an itemized list and description of the contents on the outside of each container.

E. Replace pieces bent or damaged unless repairs are authorized by the Engineer.

1.07 JOB CONDITIONS

A. Prior to fabrication of new steel members to be erected within the existing building, verify measurements by field investigation.

B. Provide anchor bolts and other anchorage items to be embedded in or attached to concrete, masonry or other materials in ample time to not delay work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Steel
   1. Structural Steel: ASTM A 36 and ASTM A 572 Grade 50, as indicated on drawings.
   2. Structural Steel Tubing: ASTM A 500, Grade B.
   3. Structural Steel Pipe: ASTM A53 Grade B.

B. Fasteners
   1. High-Strength Bolted Connections:
      a. High Strength Bolts: ASTM A 325.
      b. Carbon and Alloy Steel Nuts: ASTM A 563.
      c. Hardened Steel Washers: ASTM F 436, Type 1.
      d. Direct Tension Indicators (for use in slip-critical connections): ASTM F 959, Type 325.
   2. Anchor Bolts:
      a. Bolts: ASTM A 307, Grade A.
      b. Nuts: ASTM A 563.
      c. Washers: ANSI B18.22.1
   3. Expansion Anchors: As specified in Section 05500.
   4. Stainless Steel Bolts, Nuts, and Washers: As specified in Section 05500.
   5. Bolt Lubricant: Molybdenum disulfide base.

C. Welding Electrodes:
   1. AWS D1., Table 3.1, E70XX.
   2. Use low-hydrogen electrodes for field welding.

D. Headed Stud Type Shear Connectors (Studs): ASTM A 108. Weld in accordance with AWS D1.1, Section 7, and meet the mechanical properties of Type B studs (Table 7.1).

E. Non-Shrink, non-metallic grout: As specified in Section 03600.

2.02 FABRICATION

A. Fabricate structural steel in accordance with Drawings and referenced AISC standards.
   1. Properly mark and match-mark materials for field assembly.

B. Perform shearing, flame cutting, and chipping carefully and accurately so as not to induce residual stress in the metal being cut. Cut flame-cut edges of members subjected to dynamic loading by a mechanically guided torch or by hand, and remove all nicks. The radii of re-entrant gas-cut fillets shall be not less than 3/4 inch and as much larger as practicable. Perform flame cuttings in such manner that metal being cut is not carrying stress. Exposed edges, flame-cut by hand, shall be finished by grinding.

C. Connections: Except where welded or ASTM A 307 bolted connections are shown, use ASTM A 325 bolts for shop connections.

D. Bolt Holes: Punch, drill, subpunch, subdrill, and ream holes for bolts as required in accordance with AISC Specifications.

E. Welding: Perform all welding in accordance with AWS D1.1 except as modified herein.
   1. Perform procedure and sequence of welding so as to avoid needless distortion and minimize stresses. Straighten transverse warpage of flanges if necessary by controlled heating along outside face.
   2. Make allowance in shop for expected weld shrinkage in laying out and assembling members. Trim members to size only when most or all of welding has been completed.

F. Holes for Other Work: Provide holes required for securing other work to structural steel framing and for passage of other work through members as shown on final approved shop drawings.
   1. Cut, drill, or punch holes perpendicular to metal surface. Do not flame cut holes or enlarge by burning.
   2. Additional openings in members not shown on final approved shop drawings shall not be performed, approval of the Engineer is required.

G. Shop Painting:
   1. Surface Preparation: Power Tool Cleaning - SSPC-SP3.
   2. Apply one shop coat of primer paint to structural steel in accordance with manufacturer's recommended procedures at mil thickness specified.
   3. Do not paint areas of following areas of structural steel members:
      a. Connection plates and members where slip-critical connections are required.
      b. Surface in contact with fireproofing.
      c. Members to be encased in concrete except for the initial 2 inches of embedded area.
      d. Top flange of beam to which shear connectors to be attached.
   4. Refer to additional requirements in Section 09900.

H. Protective Coatings
   1. Galvanizing: Hot-dip galvanize steel products which are specified to be galvanized after fabrication in accordance with the requirements listed below:
   2. Specification for zinc (hot-galvanized) coatings on products fabricated from rolled, pressed and forged steel shapes, plates and strip; ASTM A 123.
   3. Specification for zinc coating (hot-dip) on iron and steel hardware; ASTM A 153.
   4. Specification for zinc coating (hot-dip) on assembled steel products; ASTM A 123.

I. Electro-Plated Zinc Coating: ASTM B 633 for the type specified.

PART 3 EXECUTION

3.01 PREPARATION

A. Before erection proceeds, verify elevations of concrete and masonry bearing surfaces and locations of anchorage for compliance.

3.02 ERECTION

A. Erect steel structures true and plumb following the match marks and in accordance with the Drawings, pertinent regulations, and referenced AISC standards.
   1. If anchor bolts are cast in substructure when it is being constructed, ensure that they are firmly held in their correct position and elevation by suitable templates.
   2. Allow concrete foundations to reach a minimum of 14-days curing time before torquing anchor bolts.

B. Thoroughly clean surfaces to be joined.

C. Align column bases and bearing plates for beams and similar structural members with steel wedges or shims. After the supported members have been aligned and properly positioned and the anchor nuts have been tightened, dry-pack the entire area under bearing plates with non-shrink non-metallic grout.

D. Use temporary bracing to resist loads to which the structures may be subjected, including erection equipment or the operations of same. Leave bracing in place as long as may be required for safety.

E. Report immediately to the Engineer, errors in shop fabrication or deformation resulting from handling or transportation which prevent the proper erection and fitting of parts.
   1. Do not field cut or alter structural members without the approval of the Engineer.

F. Bolting:
   1. For connections using high-strength steel bolts, conform to requirements of AISC Specifications.
   2. Assemble high-strength bolted parts so that they fit solidly together when assembled. Do not use gaskets or any other interposed compressible materials.
   3. Remove scale, dirt, butts and other defects liable to prevent proper seating when assembling joint surfaces, including those adjacent to washers.
   4. Clean oil, paint or lacquer from contact surfaces of slip-critical joints.
   5. Enlarge holes to admit bolts for connections only if approved by the Engineer. Make the enlargement by reaming and not by burning. Avoid hand reaming.
   6. For bearing-type connections, tighten the A 325 bolts to a snugtight condition achieved by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench to the extent that all plies of the connected material have been brought into snug contact.
   7. For slip-critical connections, tighten the A 325 bolts, nuts and direct tension indicators as indicated in ASTM F 959.

a. A representative from the direct tension indicator supplier shall be on site during initial tightening to witness and approve degree of tightening to ensure proper tensioning is achieved.
b. Place direct tension indicators under either the bolt head or the hardened washer.
c. If direct tension indicators are placed under the turned element, place a hardened round steel washer between the direct tension indicator and the turned element.

8. Arrange bolts so that heads show in areas exposed to view.
9. Ensure that holes are not enlarged and that the metal in the vicinity of the holes is not disturbed by the drifting occurring during assembly.
10. As erection progresses, perform sufficient bolting of the work to resist dead load and wind and erection loads. Perform permanent bolting when sufficient alignment has been completed to ensure as much of the structure as possible will be supported by such fastening work.
11. Erection bolts used in welded construction shall be tightened securely and left in place.

G. Field welding only permitted where approved by the Engineer or as indicated in the Drawings.

H. Prior to installation of stud shear connectors and metal decking, clean unpainted top flanges of beams of all heavy rust, mill scale, dirt, or other material.

3.03 QUALITY CONTROL

A. Inspect assembled bolted construction in accordance with AISC Specification for Structural Joints Using ASTM A 325 Bolts, Section 9.
1. For slip critical connections (shop and field) or connections subject to direct tension, test one bolt per connection.
2. Prior to the use of direct tension indicators, a representative sample of testing shall be performed in accordance with AISC Specification for Structural Joints using A325 Bolts, Section 8(d)(3).

B. Inspection of welds:
1. Provide independent testing laboratory to conduct nondestructive testing of the type, number and location specified herein, at no additional cost to the Owner.
2. Visually inspect all welds full length.
3. Perform ultrasonic testing of the entire length of weld for the following locations:
a. Complete penetration butt or tee welds.
4. Perform magnetic particle testing of the entire length for the following locations:
a. Fillet welds.
5. Use procedure and acceptability of test in accordance with the requirements of AWS D1.1.
6. Provide AWS-certified welding inspector to interpret test results.
7. Submit results of tests to Engineer.

8. Correct all deficiencies in accordance with AWS D1.1, Section 6, and have weld tested at no additional cost to the Owner.

C. Inspection of Shear Connectors.

D. Remove and replace work that does not comply with specified requirements. Additional testing performed as a result of deficiencies or noncompliance of original work shall be at expense of the Contractor.

3.04 FIELD TOUCH-UP PAINTING

A. Perform touch-up painting as specified in Section 09900.

END OF SECTION

SECTION 05400

COLD FORMED METAL FRAMING

PART 2 PRODUCTS

1.01 FRAMING MATERIALS

A. Studs and Track: ASTM C 955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.

1.02 FASTENERS

A. Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A 153/A 153M.

B. Anchorage Devices: Power actuated.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

1.02 RELATED SECTIONS:

A. Individual miscellaneous metal items as specified in various other Sections of the general construction Specifications.

1.03 REFERENCES

A. American Society For Testing and Materials:
   1. ASTM A36, Structural Steel.
   2. ASTM A307, Carbon Steel Externally Threaded Standard Fasteners.
   3. ASTM A320, Alloy-Steel Bolting Materials for Low-Temperature Service.
   4. ASTM A325, High-Strength Bolts for Structural Steel Joints.
   5. ASTM A480, Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   6. ASTM A489, Carbon Steel Eyebolts.
   7. ASTM A563, Carbon and Alloy Steel Nuts.
   8. ASTM A668, Steel Forgings, Carbon and Alloy, for General Industrial Use.
   9. ASTM F436, Hardened Steel Washers.

B. American Welding Society: AWS D1.1 Structural Welding Code.

C. Federal Specifications:
   1. Fed. Spec. FF-S-92a, Screws, Machine: Slotted, Cross Recessed or Hexagon Head.
   2. Fed. Spec. FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry) Group II (Shield, Expansion Bolt Anchor) Type 4 (Wedge expansion anchors) Class 1 (One piece steel expander with cone taper integral with stud).

1.04 SUBMITTALS

A. Shop Drawings and Product Data:
   1. Shop drawings shall identify the detail as indicated on the Engineer's Drawings and be complete as to the detail of the product and location in the project, the size of members, the methods of joining various components, the quantity, finish, the location and type of anchors and necessary measurements.
   2. Shop assemblies which require markings for erection identification shall have easy-to-read markings on the shop and erection drawings.

3. Note on shop drawings variations in tolerances or clearances between various products.
4. Use standard welding symbols of the American Welding Society on shop drawings.
5. Furnish setting diagrams, templates, and directions for the installation of metal fabrications.
6. Submit product data on type of finish paint system for both shop painting and field touch-up painting.

1.05 QUALITY ASSURANCE

A. Welder Qualifications: Welds shall be made only by welders, tackers, and welding operators who are currently qualified by tests as prescribed in the Structural Welding Code, AWS D1.1 of the American Welding Society to perform the type of work required.

1.06 DELIVERY, STORAGE AND HANDLING

A. Store steel above the ground surface on platforms, skids, blocking or other supports.

B. Protect from exposure to conditions that produce rust.

C. Store beams with webs vertical.

D. Handle steel so no parts are bent, broken, or otherwise damaged and avoid damage to other material and work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Miscellaneous Metal: Steel used for miscellaneous metal applications shall conform to ASTM A36.
   1. Steel Shapes, Plates and Bars: ASTM A36.
   2. Checkered Steel Plate: ASTM A36 with raised pattern to provide non-slip wearing surface. Thickness of the plate indicated on the Contract Drawings does not include raised portion.
   3. Stainless Steel Shapes and Bars: ASTM A276, AISC Type 304 and 316.

B. Fasteners, Anchors and Welding Materials:
   1. Machine Screws: AISC Type 304 stainless steel conforming to Fed. Spec. FF-S-92a.
   2. Stainless Steel Anchor Bolts: ASTM A320 Grade B8, AISC Type 304.
   3. Standard Steel Bolts, Nuts and Washers: ASTM A307.
   4. Steel Expansion Anchors and Stainless Steel Expansion Anchors: Conforming to Fed. Spec. FF-S-325 Group II, Type 4, Class 1, such as Hilti Kwik-Bolt, Phillips Red Head Wedge-Anchor and Molly Parabolt.

5. U-Bolts: Carbon steel with National Coarse Threads and zinc-coated finish.
6. Eyebolts: Carbon steel with National Coarse Threads and zinc-coated finish: ASTM A489.
7. High-Strength Structural Steel Bolts, Nuts and Washers:
   a. ASTM A325 Specification for Bolts.
   b. ASTM A563 Specification for Carbon and Alloy Steel Nuts.
   c. ASTM F436 Specification for Hardened Steel Washers for Use with High-Strength Bolts.
8. Steel Anchor Bolts: Shapes as indicated, ASTM A307.
9. Stainless Steel Bolts, Nuts and Washers: ASTM A320 Grade B8, AISC Type 304.
10. Headed Stud Type Shear Connectors: Cold finished carbon steel, ASTM A668, Class Designation B; similar to Nelson Stud Welding Systems.
11. Epoxy Adhesive Anchoring System: The adhesive anchor setting system shall be composed of anchors and fasteners as specified, and a self-contained cartridge system capable of dispensing both epoxy components in the proper mixing ratio.
    a. Standard Anchor Rod Assembly: Chamfered end threaded stud rod of ASTM A 307 steel with nut and washer. Stud size as indicated on Drawings.
    b. Stainless Steel Anchor/Fastener: Chamfered end threaded stud rod of AISI Type 304 stainless steel, with nut and washer of AISI Type 316 stainless steel.
    c. Adhesive Cartridge: The dual cartridge shall contain both hardener and resin and shall be dispensed from the dual cartridge through a static mixing nozzle.
       1) Two-component, 100 percent solid, non-sag paste, insensitive to moisture and meeting requirements of ASTM C 881, Type IV, Grade 3. Class A, B, and C. Shrinkage during cure shall be .00051in./in. maximum in accordance with ASTM D 2566. Compressive strength of 10,300 minimum in accordance with ASTM D 695.
       2) The Pre-mixed adhesive shall be injected directly into the prepared anchor hole. The anchor/fastener shall be inserted in the adhesive in accordance with the adhesive manufacturer's installation instructions.
    d. Acceptable Manufacturers:
       1) ITW Ramset /Red Head; C6 Adhesive.
       2) Hilti Corporation; HIT HY150 System.
       3) EPCON Adhesive Anchoring Systems.
12. Welding Electrodes: Table 4.1.1 of AWS D1.1 as required for applicable base metals and welding process.

C. Bollards: Schedule 20 black steel pipe conforming to ASTM A53 and concrete filled with 3,000 psi concrete conforming to the requirements as specified in Section 03300: Cast-In-Place Concrete.

D. Stainless Steel Plate, Sheet and Strip: ASTM A167 and A480.

E. Shop Paint: Surface preparation and painting in accordance with Section 09900.

2.02 FABRICATION

A. Insofar as possible, fit and shop assemble metal fabrications, ready for installation.

B. Fabricate in accordance with details, approved shop drawings and referenced standards.

C. Drill or punch holes required for the attachment of work of other trades and for bolted connections. Burned holes are not acceptable.

D. Welding shall be in accordance with AWS D1.1.

E. Dress smooth welds and sharp corners.

F. Make work square, plumb, straight, and true.

2.03 SHOP PAINTING

A. Surface Preparation and painting in accordance with Section 09900.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect the installed work of other trades and verify that such work is complete to the point where this work may properly commence.

3.02 PREPARATION

A. Field Measurements: Verify measurements in field before fabrication.

3.03 ERECTION

A. Erect and install miscellaneous metal and metal fabrications in accordance with details, approved shop drawings and referenced standards aligning straight, plumb and level within a tolerance of one in 200.

B. Provide suitable temporary braces and stays to hold metal fabrications in position until permanently secured.

C. Draw threaded bolt connections up tight with lock washers or other means to prevent loosening. Screw fasteners in exposed or finished surfaces may be slot or Phillips head type, but in either case, screws must be countersunk design.

D. Erect miscellaneous structural steel in accordance with the Drawings, pertinent regulations and referenced AISC standards.

3.04 INSTALLATION

A. Expansion Anchor Installation:
   1. General: In general, install expansion anchors in strict accordance with manufacturer's instructions and in accordance with the following.
   2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.
   3. Minimum Embedment: Embed expansion anchors to four and one-half bolt diameters, unless otherwise indicated on Drawings.

B. Adhesive Anchor Installation:
   1. General: In general, install adhesive anchors in strict accordance with manufacturer's instructions and in accordance with the following.
   2. Drilling Holes: Use rotary hammer type drill and make drill holes to the required diameter and depth as consistent with anchor manufacturer's instructions for size of anchors being installed.
      a. Prior to setting cartridge and anchor stud clean drilled holes free of loose material by vacuum process, finishing with a blast of compressed air, and cover hole until actual use.
   3. Anchor Rod Installation: Following cartridge installations in in-prepared drill holes, set anchor rod to the required depth. Set anchor rod truly perpendicular (normal) to the base plate of item being anchored.
   4. Minimum Embedment Table:

Adhesive Anchor Diam. (Inches)	3/8	1/2	5/8	3/4	7/8	1
Embedment Depth (Inches)	3-1/2	4-1/4	5	6-5/8	6-5/8	8-1/4

3.05 FIELD TOUCH-UP PAINTING

A. Provide field touch-up painting in accordance with Section 09900.

END OF SECTION

SECTION 05510

METAL STAIRS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Stairs with concrete treads.

B. Structural steel stair framing and supports.

C. Pan treads to receive concrete fill, and landings.

1.02 RELATED SECTIONS

A. Section 03300 - Cast-in-Place Concrete: Concrete fill in stair pans and landings; mesh reinforcement for landings.

B. Section 03300 - Cast-in-Place Concrete: Placement of metal anchors in concrete.

C. Section 04810 - Unit Masonry Assemblies: Placement of metal fabrications in masonry.

D. Section 05520 - Handrails and Railings: Metal handrails for the stairs specified in this section.

E. Section 09900 - Paints and Coatings: Paint finish.

1.03 REFERENCES

A. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2005.

B. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.

C. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2004b.

D. ASTM A 325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2005.

E. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardened; 2005b.

F. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 1998.

G. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2006.

H. NAAMM AMP 510 - Metal Stairs Manual; The National Association of Architectural Metal Manufacturers; 1992, Fifth Edition.

I. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).

J. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

K. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed. 2004).

1.04 DESIGN REQUIREMENTS

A. Fabricate metal stairs to comply with NAAMM AMP 510, Class Architectural.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories.
   1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.

C. Welders' Certificates.

1.06 QUALITY ASSURANCE

A. Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in Lexington, KY, or personnel under direct supervision of such an engineer.

B. Welder Qualifications: Show certification of welders employed on the Work, verifying AWS qualification within the previous 12 months.

PART 2 PRODUCTS

2.01 METAL STAIRS - GENERAL

A. Metal Stairs: Provide stairs of the design specified, complete with landing platforms, vertical and horizontal supports, railings, and guards, fabricated accurately for anchorage to each other and to building structure.
   1. Regulatory Requirements: Provide stairs and railings complying with the most stringent requirements of local, State, and federal regulations; where requirements of the contract documents exceed those of regulations, comply with the contract documents.
   2. Structural Design: Provide complete stair and railing assemblies complying with the applicable local code.
   3. Dimensions: As indicated on drawings.
   4. Shop assemble components; disassemble into largest practical sections suitable for transport and access to site.
   5. No sharp or rough areas on exposed travel surfaces and surfaces accessible to touch.
   6. Separate dissimilar metals using paint or permanent tape.

B. Metal Jointing and Finish Quality Levels:

1. Architectural: All joints as inconspicuous as possible, whether welded or mechanical.
   a. Welded Joints: Continuously welded and ground smooth and flush.
   b. Mechanical Joints: Butted tight, flush, and hairline; concealed fastenings only.
   c. Exposed Edges and Corners: Eased to small uniform radius.
   d. Metal Surfaces to be Painted: Sanded or ground smooth, suitable for highest quality gloss finish.

C. Fasteners: Same material or compatible with materials being fastened; type consistent with design and specified quality level.

D. Anchors and Related Components: Same material and finish as item to be anchored, except where specifically indicated otherwise; provide all anchors and fasteners required.

2.02 METAL STAIRS WITH CONCRETE TREADS

A. Jointing and Finish Quality Level: Architectural, as defined above.

B. Risers: Closed.

C. Treads: Metal pan with field-installed concrete fill.
   1. Concrete Depth: 1-1/2 inches (38 mm), minimum.
   2. Tread Pan Material: Steel sheet.
   3. Tread Pan Thickness: As required by design; 14 gage, 0.075 inch (1.9 mm) minimum.
   4. Pan Anchorage to Stringers: Welded or bolted to carrier angles welded or bolted to stringers.
   5. Concrete Reinforcement: None.
   6. Concrete Finish: For resilient floor covering.

D. Risers: Same material and thickness as tread pans.
   1. Riser/Nosing Profile: Sloped riser with rounded nosing of minimum radius.
   2. Nosing Depth: Not more than 1 inch (25 mm) overhang.
   3. Nosing Return: Flush with top of concrete fill, not more than 1/2 inch (12 mm) wide.

E. Stringers: Rolled steel channels.
   1. Stringer Depth: 12 inches (305 mm).
   2. End Closure: Sheet steel of same thickness as risers welded across ends.

F. Landings: Same construction as treads, supported and reinforced as required to achieve design load capacity.

2.03 HANDRAILS AND GUARDS

A. Wall-Mounted Rails: As specified in Section 05520.

B. Guards: Pipe railings as specified in Section 05520.

2.04 MATERIALS

A. Steel Sections: ASTM A 36/A 36M.

B. Ungalvanized Steel Sheet: ASTM A 1008/A 1008M, Designation SS, Grade 33, Type 1.

C. Concrete Fill: Type specified in Section 03300.

D. Concrete Reinforcement: Mesh type as detailed, unfinished.

E. Steel Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, galvanized to ASTM A 153/A 153M where connecting galvanized components.

F. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; consistent with design of stair structure.

G. Welding Materials: AWS D1.1; type required for materials being welded.

H. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

I. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

2.05 SHOP FINISHING

A. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

B. Do not prime surfaces in direct contact with concrete or where field welding is required.

C. Prime Painting: Use specified shop- and touch-up primer.
1. Preparation of Steel: In accordance with SSPC-SP 2, Hand Tool Cleaning.
2. Number of Coats: One.

2.06 COMPONENTS

A. Metal Pan Stair Treads: Concrete in metal pan; 2 inches (____ mm) deep; smooth surface; non-slip edge.

2.07 FABRICATION - GENERAL

A. Fit and shop assemble components in largest practical sections, for delivery to site.

B. Fabricate components with joints tightly fitted and secured.

C. Continuously seal joined pieces by intermittent welds and plastic filler.

D. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component, except where specifically noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

G. Fabricate components accurately for anchorage to each other and to building structure.

2.08 FABRICATION - PAN STAIRS AND LANDINGS

A. Fabricate stairs and landings with closed risers and treads of metal pan construction using ungalvanized steel sheet, ready to receive concrete.

B. Form treads and risers with minimum 14 gage (____ mm thick) sheet steel stock.

C. Secure reinforced tread pans to stringers with clip angles; welded in place.

D. Form stringers with rolled steel channels, 12 inches (300 mm) deep.

E. Form landings with minimum 14 gage (____ mm thick) sheet stock. Reinforce underside with channels to attain design load requirements.

F. Prime paint components.

2.09 FINISHING

A. Prepare surfaces to be primed in accordance with SSPC-SP 2.

B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

C. Do not prime surfaces in direct contact with concrete or where field welding is required.

D. Prime paint items with one coat.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. When field welding is required, clean and strip primed steel items to bare metal.

B. Supply items required to be cast into concrete and embedded in masonry with setting templates.

3.03 INSTALLATION

A. Install components plumb and level, accurately fitted, free from distortion or defects.

B. Provide anchors, plates and angles required for connecting stairs to structure.

C. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

D. Provide welded field joints where specifically indicated on shop drawings. Perform field welding in accordance with AWS D1.1.

E. Other field joints may be either welded or bolted provided the result complies with the limitations specified for jointing quality levels.

F. Field bolt and weld to match shop bolting and welding. Conceal bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

G. Mechanically fasten joints butted tight, flush, and hairline. Grind welds smooth and flush.

H. Obtain approval prior to site cutting or creating adjustments not scheduled.

I. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete. Field finish paint steel stair, see specification 09900 for finish paint.

3.04 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

END OF SECTION

SECTION 05520

HANDRAILS AND RAILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Wall mounted handrails.

B. Stair handrails and guardrails.

C. Free-standing railings at interior walkways around filters.

D. Free-standing railings at steps and raised platforms.

1.02 RELATED SECTIONS

A. Section 03300 - Cast-in-Place Concrete: Placement of anchors in concrete.

B. Section 04810 - Unit Masonry Assemblies: Placement of anchors in masonry.

C. Section 05510 - Metal Stairs: Attachment plates for handrails specified in this section.

D. Section 09900 - Paints and Coatings: Paint finish.

1.03 REFERENCES

A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; American Architectural Manufacturers Association; 1998.

B. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2005.

C. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2002.

D. ASTM A 500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2003a.

E. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire; 2003.

F. ASTM B 211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric); 2003.

G. ASTM B 241/B 241M - Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube; 2002.

H. ASTM B 429 -

I. ASTM B 483/B 483M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Tubes and Pipe for General Purpose Applications; 2003.

J. ASTM E 935 - Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings; 2000.

K. ASTM E 985 - Standard Specification for Permanent Metal Railing Systems and Rails for Buildings; 2000.

L. SSPC-Paint 15 - Steel Joist Shop Paint; The Society for Protective Coatings; 1999 (Ed. 2004).

1.04 SUBMITTALS

A. Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

PART 2 PRODUCTS

2.01 RAILINGS - GENERAL REQUIREMENTS

A. Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E 985 and applicable local code.

B. Design railing assembly, wall rails, and attachments to resist a single concentrated force of 200 lbs (____ N) applied in any direction and at any point along the top without damage or permanent set. Test in accordance with ASTM E 935.

C. Design railing assembly, wall rails, and attachments to resist a force of 50 lbs (____ N) per linear foot applied in any direction along the top without damage or permanent set. Test in accordance with ASTM E 935.

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: See drawingsand individual material types below for sizes, materials, configurations and heights.

F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
   1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
   2. For anchorage to masonry, provide brackets to be embedded in masonry, for bolting anchors.
   3. Posts: Provide adjustable flanged brackets.

G. Provide mechanical and welding fittings where indicated and as required to join lengths, seal open ends, and conceal exposed mounting bolts and nuts, including but not limited to elbows, T-shapes, splice connectors, flanges, escutcheons, and wall brackets.

2.02 ALUMINUM MATERIALS

A. Aluminum Pipe: Schedule 40; ASTM B 429, ASTM B 241/B 241M, or ASTM B 483/B 483M.

B. Aluminum Tube: Minimum wall thickness of 0.127 inch (3.2 mm); ASTM B 429, ASTM B 241/B 241M, or ASTM B 483/B 483M.

C. Solid Bars and Flats: ASTM B 211 (ASTM B 211M).

D. Non-Weld Mechanical Fittings: Slip-on cast aluminum, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.

E. Welding Fittings: No exposed fasteners; cast aluminum.

F. Exposed Fasteners: No exposed bolts or screws.

2.03 FIBERGLASS RAILING SYSTEM

A. Fiberglass Reinforced Plastic Components: Pultruded fiberglass tubing and components made with a fire retardant polyester resin which meets the ASTM E-84 test for flame spread of 25 or less and contains a UV inhibitor.

B. Design the rail system to meet the configuration and loading requirements of OSHA 1910.23, with a minimum factor of safety on loading of 2.0.

C. Non-Weld Mechanical Fittings: All required fittings furnished by the FRP manufacturer and factory installed, or shipped loose to be epoxied and riveted together in the field by the contractor, per the manufacturer's recommendations .

D. Rails and Posts: 2 inch square fiberglass tube with 5/32" thick walls.

E. Kickplates: 4 inch x 1/2" x 1/8" thick pultruded fiberglass shape.

F. Exposed Fasteners: Fasten posts with stainless steel anchor bolts or studs, 1/2" diameter, extending no less than 2 1/4" into concrete or into a minimum thickness of 1/4" structural steel or pultruded fiberglass.

G. Finish: As selected from manufacturer's standard finish(es), color as indicated on approved shop drawings.

H. Manufacturers:
1. Strongrail Company; Product: Safrail. www.strongwell.com
2. Structural Fiberglass, Inc.. www.structuralfiberglass.com
3. IMCO Reinforced Plastics, Inc.; Product: Guardrail.

2.04 STEEL RAILING SYSTEM

A. Steel Tube: ASTM A 500, Grade B cold-formed structural tubing.

B. Steel Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.

C. Non-Weld Mechanical Fittings: Slip-on, galvanized malleable iron castings, for Schedule 40 pipe, with flush setscrews for tightening by standard hex wrench, no bolts or screw fasteners.

D. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.

E. Exposed Fasteners: No exposed bolts or screws.

F. Straight Splice Connectors: Steel concealed spigots.

G. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.05 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure.

B. Fit and shop assemble components in largest practical sizes for delivery to site.

C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.

D. Welded Joints:
1. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
2. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.

2.06 ALUMINUM FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.

C. Apply one coat of bituminous paint to concealed aluminum surfaces that will be in contact with cementitious or dissimilar materials.

3.03 INSTALLATION

A. Install in accordance with manufacturer's instructions.
1. Locate FRP posts no greater than 18", nor less than 9" from horizontal or vertical change in handrail direction. Locate post centers no greater than 72" o.c. on any straight run of rail or 48" o.c. on any inclined rail section.

B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.

C. Anchor railings securely to structure.

D. Field weld anchors as indicated on shop drawings. Touch-up welds with primer. Grind welds smooth.

E. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.04 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4 inch (6 mm) per floor level, non-cumulative.

B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

C. Maximum Out-of-Position: 1/4 inch (6 mm).

3.05 SCHEDULE

A. Stairs #1, #2, #3 and #4: Combination steel and aluminum railing system as detailed on sheet A14.

B. FRP Rails: Fiberglass Reinforced Plastic railing system in rooms #102, #105, #109 and #111 and as detailed on sheet A1.

C. Steel Pipe Rails: In all locations shown on the drawings and not listed above as detailed on sheet A1.

END OF SECTION

SECTION 05600

ALUMINUM FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Provision of aluminum fabrications and appurtenant components.

1.02 RELATED SECTIONS

A. Division 3 - Concrete.

B. Metal Fabrications: Section 05500.

1.03 REFERENCES

A. American Institute of Steel Construction (AISC) standards as apply to specified products.

B. American National Standards Institute:
   1. ANSI B18.2.l, Square and Hex Bolts and Screws, Including Askew Head Bolts, Hex Cap Screws and Lag Screws.

C. American Society For Testing and Materials:
   1. ASTM A194, Carbon and Alloy Steel Nuts for Bolts for High- Pressure and High-Temperature Service.
   2. ASTM A320, Alloy Steel Bolting Materials for Low- Temperature Service.
   3. ASTM A489, Carbon Steel Eyebolts.
   4. ASTM B209, Aluminum-Alloy Sheet and Plate.
   5. ASTM B221, Aluminum-Alloy Extruded Bars, Wire, Shapes and Tubes.
   6. ASTM B241, Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
   7. ASTM B308, Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded.

D. American Welding Society:
   1. AWS Handbook Section 4, Chapter 69 Aluminum and Aluminum Alloys.
   2. AWS D1.1, Structural Welding Code

E. Federal Specifications:
   1. Fed. Spec. FF-S-92a, Screws, Machine: Slotted, Cross- Recessed or Hexagon Head.
   2. Fed. Spec. FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry) Group II (Shield, Expansion Bolt Anchor) Type 4 (Wedge expansion anchors) Class 1 (One piece steel expander with cone taper integral with stud).
   3. Fed. Spec. TT-P-645, Primer, Paint, Zinc-Chromate, Alkyd Type.

F. National Association of Architectural Metal Manufacturers:
   1. NAAMM Metal Bar Grating Manual.

1.04 SUBMITTALS

A. Shop Drawings:
   1. Submit Shop Drawings in accordance with Section 1300, demonstrating compliance with Specifications.
   2. Provide easy-to-read markings on Shop Drawings for assemblies requiring erection identification marks.
   3. Note tolerance variations or clearance requirements.
   4. Use American Welding Society standard welding symbols.
   5. Furnish setting diagrams, templates, and installation directions.
   6. Submit both shop and touchup paint system data.

1.05 QUALITY ASSURANCE

A. Welder Qualifications: As specified in Section 05500.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle pre-finished products in a manner that will prevent material damage and deterioration or contamination from elements.

B. Provide protective wrapping on pre-finished aluminum products and maintain such in place until project is ready for final inspection.

PART 2 PRODUCTS

2.01 MATERIALS

A. Exterior Aluminum Floor Access Doors: Door sizes and leafs as indicated on Contract Drawings.
   1. Door of 1/4 inch aluminum diamond pattern plate to withstand a live load of 300 psf. or H-20 loading as indicated on Drawings. Double leaf units with center drip channel welded to one leaf and designed to drain into main channel frame.
   2. Hardware:
      a. Compression spring operators.
      b. Automatic hold-open arm with release handle.
      c. Slam lock with removable key wrench.
      d. Flush lift handle.
      e. Stainless steel.
      f. Heavy-duty check chain on double leaf doors.
   3. Mill-finish door plate and bituminous coating on frame exterior in contact with concrete.
   4. Manufacturer's 5-year guarantee against defects in material and workmanship.

5. Telescoping tubular safety post extending 42 inches above adjacent surface at locations with ladder.
   a. Hot dip galvanized finish.
6. Drainable Frame: Types "J" and "JD", 1/4 inch extruded aluminum channel frame continuously welded with 1-1/2-inch drain coupling for connection to disposal system with continuous anchor flange (min. 1 inch leg) on perimeter and neoprene bumper on all sides.
   a. Acceptable Manufacturers:
      1) Bilco Company; Watertight Type "J" (Single Leaf) and "JD" (Double Leaf) and Type "PCM" or "PCDM."

B. Interior Aluminum Floor Access Doors: Door sizes and leafs as indicated on Contract Drawings.
1. Door Leaf(s): 1/4 inch aluminum diamond plate reinforced with aluminum stiffeners to withstand a live load of 150 lbs. per square foot.
2. Frame: 1/4 inch aluminum with built-in neoprene cushion and with strap anchors bolted to exterior.
3. Door(s): Equip with cast steel hinges bolted to underside. Pivot on torsion bars. Door open to 90 degrees and lock automatically. Provide vinyl grip handle release for closing.
4. Lock: Snap lock with removable handle.
5. Hardware: Stainless Steel.
6. Acceptable Manufacturers:
   a. Bilco Company - Type "K" or "KD."

C. Aluminum Fabrications:
1. Aluminum Structural Shapes: Aluminum alloy 6061-T6 conforming to ASTM B308, rolled or extruded. Shapes and thicknesses as indicated on Contract Drawings.
2. Aluminum Rod and Bars: Aluminum alloy 6061-T6 conforming to ASTM B221. Dimensions as indicated on Contract Drawings.
3. Aluminum Sheet and Plate: Aluminum alloy 6061-T6 conforming to ASTM B209. Thickness as indicated on Contract Drawings.
4. Checkered Aluminum Plate: Aluminum alloy 6061-T6 conforming to ASTM B209. Thickness of plate indicated on Contract Drawings does not include raised portion.

D. Fasteners, Anchors and Bolts: As specified in Section 05500.

E. Hardware and Miscellaneous Items:
1. Eye Bolts: Carbon Steel conforming to ASTM A489.
2. Machine Screws: AISC Type 304 stainless steel conforming to Fed. Spec. FF-S-92a.
3. Hexagon Head Bolts: ANSI B18.2.1 with bright finish.
4. Neoprene Gasket: Solid neoprene rubber commercial grade (durometer 55/65) with 1500 psi tensile strength.

5. Stainless Steel Expansion Anchors: Conforming to Fed. Spec. FF-S-325 Group II, Type 4, Class 1, such as Hilti Kwik-Bolt, Phillips Red Head Wedge-Anchor and Molly Parabolt.
6. U-Bolts and Standard Bolts, Nuts and Washers: ASTM A194 and ASTM A320.
7. Guard Chain: Individually welded straight link AISC Type 316 stainless steel with stainless steel hook and eyes.

F. Aluminum Grating: Removable type, fabricated panel sizes and thickness as indicated on Drawings. Where panel sizes are not indicated, limit panel weights to a maximum of 120 pounds each. Construction details in conformance with NAAMM Metal Bar Grating Manual.
   1. Performance Criteria: Grating depth designed for maximum deflection of 1/4 inch under 100 psf uniform load.
      a. Maximum Stress: 12,000 psi for clear span shown on Drawings.
      b. Bearing Bars: Aluminum alloy 6063-T6 conforming to ASTM B221.
      c. Cross Bars and Bent Connecting Bars: Aluminum alloy 6063-T5 conforming to ASTM B221.
      d. Bar Spacing:
         1) Bearing Bars: 1-3/16 inch center-to-center.
         2) Cross Bars: 4 inch center-to-center.
      e. Bar Connection: Mechanically lock cross bars to bearing bars.
      f. Anchor Clips: Galvanized steel or stainless steel saddle clips, number as recommended by manufacturer.
      g. Aluminum Bearing Angle: Aluminum alloy 6061-T6 conforming to ASTM B308.
      h. Banding: Grating bar ends banded same depth as bars. Openings cutting two or more bearing bars require banding. Openings for pipes, ducts, conduits, and similar objects require banding.
      i. Openings Through Panels: Split panels in two individual sections to facilitate removal of panels at pipes, ducts, conduits, and similar objects passing through grating panels.
      j. Acceptable Manufacturers:
         1) Ohio Gratings, Inc.; Series 19SGF
         2) Intertec Corp.; AL-14 Series
         3) Seidelhuber Metal Products, Inc.

G. Aluminum Ladders (Interior): Provide OSHA approved design:
   1. Railings: Fabricate from extruded aluminum alloy 6063-T6 (6063-T5 not acceptable) schedule 40 railing.
   2. Bars: Aluminum alloy 6063-T6 conforming to ASTM B221.
   3. Shapes: Aluminum alloy 6063-T6 conforming to ASTM B308.
   4. Rungs: Tube or channel shape and of aluminum alloy 6063-T6 conforming to ASTM B308. Rungs to have serrated tread surface. Rungs able to withstand 1,000 pound load without failure.
   5. Finish: Mill Aluminum.

6. Ladder Up Safety Post: Telescoping tubular steel with stainless steel spring balance mechanism. Acceptable manufacturer: Bilco Company. Provide safety post at all ladder locations.

H. Aluminum Ladders (Exterior): Provide OSHA approved design.
   1. Railings: Provide heavy-duty tubular rails assembled from two interlocking aluminum alloy 6063-T5 extrusions no less than 0.125 inch wall thickness by 3 inches wide. Extrusions connected by welding with final tube surfaces to be clean, smooth and burr-free.
   2. Bars: Aluminum alloy 6063-T5.
   3. Shapes: Aluminum alloy 6063-T5.
   4. Rungs: 1-1/4 inches square tubular aluminum extrusions, alloy 6063-T5, deeply serrated on all sides. Rungs able to withstand 1,000 pound load without failure.
   5. Safety Cage: Fabricated from 3/16 inch by 2 inch aluminum bar, alloy 6063-T5.
   6. Landing Platform: Provide non-slip deck of aluminum serrated treads and aluminum channels. Provide 1-1/2 inch tubular aluminum guardrails. Aluminum alloy to be 6063-T5.
   7. Security Door: Provide security door formed from 0.125 inch thick aluminum sheet, alloy 5005. Height as indicated on Contract Drawings. Provide continuous piano hinge and heavy-duty forged steel locking hasps.
   8. Finish: Mill Aluminum.
   9. Acceptable Manufacturer:
      a. O'Keefe's Inc.

I. Welded Aluminum Pipe Railings: Provide shop or factory fabricated welded joint assemblies as indicated on Contract Drawings.
   1. Railings: 1-1/2 inch (1.90 inch O.D.) Schedule 40 pipe of aluminum alloy 6061-T6, ASTM B241.
   2. Posts: Fabricate from extruded aluminum alloy 6061-T6, 1-1/2 inch (1.90 inch O.D.) Schedule 40 pipe.
   3. Fabrication: Maintain quality of workmanship by careful preparation, including accurate notching and fitting of pieces. Make bends without use of fittings, where practical. Make railing sections as long as practical but not to exceed 20 feet. Make intersection of rails and posts by coping pipe and continuously welding. Fabricate top rail continuous over posts, and posts continuous from base to top rail.
   4. Welding: Perform welding in raised beads. Exercise care to protect manufacturers factory (anodized) finish during welding. Remove finish in immediate area of welds for conductivity. Finish welds by filing and polishing to remove raised weld material, exercising care to attain same texture of factory satin finish. Welds conforming to AWS D1.1.
   5. Toe Plate: Conform to OSHA standards. Minimum of 4 inches high. Attach to posts with clamps which allow for expansion and contraction between posts. Toe plates set 1/4 inch above walking surface. Toe plates shipped loose in stock lengths, as shown on Contract Drawings, with pre-manufactured corners for field installation.

6. Wall Bracket: Extruded aluminum wall bracket as manufactured by Tri-Tech, Inc. (TM10) or Julius Blum and Co., Inc. (498).
7. Finish: Finish pipe free of scratches and other surface blemishes. Finish railing as follows:
   a. At all locations: Finish to be Architectural Class 1 Anodic Coating (AA-M12C 22A 31), Natural Anodize.
8. Acceptable Manufacturers:
   a. Julius Blum and Co., Inc.
   b. Tri-Tech. O.S.H.A. Rail.

J. Setting Grout: Use for installing posts and post sleeves. Premixed non-shrink grout formulated for wet areas such as Hallemite Lehn & Fink Industrial SUPER POR-ROK or Metalcrete Manufacturing Co. WEDJROX.

K. Cast Abrasive Nosings: Cast aluminum with cross hatched surface, No. 20 virgin grain Aluminum Oxide abrasive, integrally cast into walking surface to a minimum depth of 1/32 inch, and a feature strip on back edge.
1. Concealed anchor bolts 1/4 inch diameter by 1 inch long cast integrally with nosing.
2. Aluminum to be No. 43 prime ingot; low copper content and corrosion resistant.
3. Cross hatching: 1/16 inch deep minimum.
4. Nosing: 3 inches deep, extending to within 6 inches of edge of tread at each end.
5. Acceptable Manufacturers:
   a. American Abrasive Metals Company; Style A.
   b. Wooster Products, Inc.; Type 101.
   c. Safe-T Metal Company, Inc.; Style AX.
   d. American Safety Tread Co., Inc.; Style 801.

L. Stair Tread: Aluminum tread with carrier angle or plate and 1-1/4 inch checkered plate nosing conforming to NAAMM metal bar grating manual.
1. Bearing and Cross Bars: Aluminum alloy 6063-T6 conforming to ASTM B221.
2. Bar Spacing:
   a. Bearing Bars: 1-3/16 inches center to center.
   b. Cross Bars: 4 inches center to center.
3. Bar Connection: Mechanically lock cross bars to bearing bars.

M. Paint (Dissimilar Surface Isolation Material):
1. Zinc Chromate Primer: Fed. Spec. TT-P-645.
2. Mineral filled coal tar pitch: Tenemec 46-449, Carboline, MAB, or Sherwin Williams.

2.02 FABRICATION

A. Insofar as possible, fit and shop assemble aluminum fabrications ready for installation.

B. Fabricate in accordance with details, approved Shop Drawings, and referenced standards.

C. Drill or punch holes required for attachment of work of other trades and for bolted connections. Burned holes are not acceptable.

D. Weld Aluminum in accordance with AWS Handbook Section 4, Chapter 69.

E. Dress smooth welds and sharp corners.

F. Fabricate work square, plumb, straight, and true.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect installed work of other trades and verify such work is complete to point where this work may properly commence.

3.02 PREPARATION

A. Field Measurements: Verify measurements in field before fabrication.

3.03 ERECTION

A. Erect and install in accordance with details, approved shop drawings and referenced standards, aligning straight, plumb and level with a tolerance of one in 200.

B. Provide suitable temporary braces and stays to hold work in position until permanently secured.

C. Draw threaded bolt connections up tight with lock washers or other means to prevent loosening. Screw fasteners in exposed or finished surfaces, may be slot or Phillips head type, but in either case, screws must be counter-sunk design.

3.04 INSTALLATION

A. Aluminum Pipe Railing Installation: Install pipe railing in accordance with manufacturer's specifications. Provide posts in unspliced lengths with installation spacing on 5 foot centers unless indicated otherwise on Contract Drawings.
   1. Provide lower rails of single unspliced length between posts. Top rails continuous whenever possible, and where possible, be attached to a minimum of three posts.
   2. Install expansion joints where required, and provide drainage weep holes for exterior installations and interior installations subject to humidity.
   3. Where railings are installed in exterior locations, and set in sleeves previously formed into concrete, fill that portion of post set in sleeve with Setting Grout

filled to level of weep hole. Provide sleeves and coordinate with work of Division 3 concrete when such work is in progress.

B. Expansion Anchor Installation:
   1. General: Install expansion anchors in strict accordance with manufacturer's instructions and in accordance with following.
      a. Drilling Holes: Use rotary hammer type drill and make drill holes to required diameter and depth consistent with anchor manufacturer's instructions for size of anchor being installed.
      b. Minimum Embedment: Embed expansion anchors to 4-1/2 bolt diameters, unless otherwise indicated on Contract Drawings. A safety factor of 4 applied to expansion bolt pullout values published by manufacturer.

C. Dissimilar Surfaces Isolation:
   1. Paint aluminum surfaces at point of contact with wood, concrete or masonry construction with one coat (minimum dry mil thickness - 5.0 mils) of bituminous paint, mylar isolators or other approved material.
   2. Paint aluminum surfaces at point of contact with steel with one coat of zinc chromate primer.
   3. Clean away excess or misplaced paint materials from railing surfaces and adjoining construction materials.

END OF SECTION

SECTION 06100

ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preservative treatment of wood.

B. Fire retardant treatment of wood.

C. Telephone and electrical panel boards.

D. Wood nailers and curbs for roofing and items installed on roof.

E. Concealed wood blocking for support of toilet and bath accessories and wall cabinets.

F. Miscellaneous wood nailers and furring strips.

1.02 RELATED SECTIONS

A. Section 04810-Unit Masonry Assemblies: Setting anchors in masonry.

B. Section 05500 - Metal Fabrications: Miscellaneous steel connectors and support angles for wood framing.

C. Section 08520-Aluminum Windows: Window openings to receive wood blocking.

1.03 REFERENCES

A. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2005.

B. ASTM D 2898 - Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing; 1994 (Reapproved 2004).

C. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.

D. AWPA C2 - Lumber, Timber, Bridge Ties and Mine Ties -- Preservative Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.

E. AWPA C20 - Structural Lumber -- Fire Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.

F. AWPA C27 - Plywood -- Fire-Retardant Treatment by Pressure Processes; American Wood-Preservers' Association; 2002.

G. AWPA U1 - Use Category System: User Specification for Treated Wood; American Wood-Preservers' Association; 2005.

H. PS 1 - Construction and Industrial Plywood; National Institute of Standards and Technology (Department of Commerce); 1995.

I. PS 20 - American Softwood Lumber Standard; National Institute of Standards and Technology (Department of Commerce); 2005.

J. SPIB (GR) - Grading Rules; Southern Pine Inspection Bureau, Inc.; 2002.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide technical data on wood preservative materials and application instructions.

C. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
   1. Lumber of other species or grades, or graded by other agencies, is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.

B. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.

C. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

1.06 DELIVERY, STORAGE, AND HANDLING

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Lumber fabricated from old growth timber is not permitted.

B. Provide sustainably harvested wood; see Section 01600 for requirements.

C. Provide wood harvested within a 500 mile (535 km) radius of the project site; see Section 01600 for requirements for locally-sourced products.

2.02 DIMENSION LUMBER

A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Miscellaneous Blocking, Furring, and Nailers:
   1. Lumber: S4S, No. 2 or Standard Grade.
   2. Boards: Standard or No. 3.

2.03 CONSTRUCTION PANELS

A. Other Applications:
1. Concealed Plywood: PS 1, C-C Plugged, exterior grade.
2. Exposed Plywood: PS 1, A-D, interior grade.
3. Electrical Component Mounting: APA rated sheathing, fire retardant treated.

2.04 ACCESSORIES

A. Fasteners and Anchors:
1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
2. Anchors: Expansion shield and lag bolt type for anchorage to solid masonry or concrete.

B. Sill Flashing: As specified in Section 07620.

2.05 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

B. Fire Retardant Treatment:
1. Exterior Type: AWPA Use Category UCFB, Commodity Specification H (Treatment C20 for lumber and C27 for plywood), chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E 84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D 2898.
   a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
2. Interior Type A: AWPA Use Category UCFA, Commodity Specification H (Treatment C20 for lumber and C27 for plywood), low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E 84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
   a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
   b. Treat rough carpentry items as indicated .
   c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:
1. Manufacturers:
   a. Arch Wood Protection, Inc; Product ____: www.wolmanizedwood.com.
   b. Chemical Specialties, Inc; Product ____: www.treatedwood.com.
   c. Osmose, Inc; Product ____: www.osmose.com.

2. Preservative Pressure Treatment of Lumber Above Grade: AWPA Use Category UC3B, Commodity Specification A (Treatment C2) using waterborne preservative to 0.25 lb/cu ft (4.0 kg/cu m) retention.
   a. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
   b. Treat lumber in contact with roofing, flashing, or waterproofing.
   c. Treat lumber in contact with masonry or concrete.
   d. Treat lumber in other locations as indicated.

PART 3 EXECUTION

3.01 INSTALLATION OF ACCESSORIES AND MISCELLANEOUS WOOD

A. Curb roof openings. Form corners by alternating lapping side members.

3.02 INSTALLATION OF CONSTRUCTION PANELS

3.03 SITE APPLIED WOOD TREATMENT

A. Apply preservative treatment compatible with factory applied treatment at site-sawn cuts, complying with manufacturer's instructions.

B. Allow preservative to dry prior to erecting members.

3.04 TOLERANCES

A. Variation from Plane (Other than Floors): 1/4 inch in 10 feet (2 mm/m) maximum, and 1/4 inch in 30 feet (7 mm in 10 m) maximum.

3.05 CLEANING

A. Waste Disposal: Comply with the requirements of Section 01732.
   1. Comply with applicable regulations.
   2. Do not burn scrap on project site.
   3. Do not burn scraps that have been pressure treated.
   4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or "waste-to-energy" facilities.

B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.

C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION

SECTION 06410

CUSTOM CABINETS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Specially fabricated cabinet units.

B. Countertops.

C. Cabinet hardware.

1.02 RELATED SECTIONS

A. Section 06100 - Rough Carpentry.

B. Section 09900 - Paints and Coatings: Site finishing of cabinet exterior and interior.

1.03 REFERENCES

A. ANSI A135.4 - American National Standard for Basic Hardboard; 2004.

B. ANSI A208.2 - American National Standard for Medium Density Fiberboard for Interior Use; 2002.

C. AWI/AWMAC (QSI) - Architectural Woodwork Quality Standards Illustrated; Architectural Woodwork Institute and Architectural Woodwork Manufacturers Association of Canada; 2006, 8th Ed., Version 2.0.

D. BHMA A156.9 - American National Standard for Cabinet Hardware; Builders Hardware Manufacturers Association; 2003 (ANSI/BHMA A156.9).

E. NEMA LD 3 - High-Pressure Decorative Laminates; National Electrical Manufacturers Association; 2005.

F. PS 1 - Construction and Industrial Plywood; National Institute of Standards and Technology (Department of Commerce); 1995.

1.04 SUBMITTALS

A. Shop Drawings: Indicate materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware location and schedule of finishes.

B. Product Data: Provide data for hardware accessories.

C. Samples: Submit manufacturer's full range of plastic laminate colors for selection during submittal approval.

D. LEED Report: Submit for wood products made from sustainably harvested wood, salvaged and reused wood, wood fabricated from recovered timber, and locally-sourced wood, as specified in Section 01355.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Premium quality.

B. Perform cabinet construction in accordance with AWI/AWMAC Architectural Woodwork Quality Standards Illustrated, Premium quality.

C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

1.06 DELIVERY, STORAGE, AND PROTECTION

A. Protect units from moisture damage.

1.07 ENVIRONMENTAL REQUIREMENTS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

PART 2 PRODUCTS

2.01 WOOD-BASED COMPONENTS

A. Wood fabricated from old growth timber is not permitted.

2.02 PANEL MATERIALS

A. Softwood Faced Plywood:
   1. Exposed Surfaces: NIST PS 1; APA A-A Grade, plain-sliced birch face veneer, Interior rated adhesives, core of particleboard, thickness as required.

B. Medium Density Fiberboard (MDF): ANSI A208.2; type as specified in AWI/AWMAC Architectural Woodwork Quality Standards Illustrated; composed of wood fibers pressure bonded with moisture resistant adhesive to suit application; sanded faces; thickness as required.
   1. Use for concealed components.
   2. Use as backing for plastic laminate unless otherwise indicated.

C. Hardboard: AHA A135.4; Pressed wood fiber with resin binder, Class 1 - Tempered, 1/4 inch (6 mm) thick, smooth two sides (S2S); use for drawer bottoms, dust panels, and other components indicated on drawings.

D. Hardwood Edgebanding: Use solid hardwood edgebanding matching species, color, grain, and grade for exposed portions of cabinetry.

2.03 LAMINATE MATERIALS

A. Manufacturers:
   1. Formica Corporation: www.formica.com.
   2. Panolam Industries International, Inc\Nevamar: www.nevamar.com.
   3. Wilsonart International, Inc: www.wilsonart.com.
   4. Substitutions: See Section 01600 - Product Requirements.

B. High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications and as follows:

1. Horizontal Surfaces: HGS, 0.048 inch (1.22 mm) nominal thickness, color as selected, finish as selected.
2. Vertical Surfaces: VGS, 0.028 inch (0.71 mm) nominal thickness, through color, color as selected, finish as selected.
3. Laminate Backer: BKL, 0.020 inch (0.51 mm) nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.

2.04 COUNTERTOPS

A. Plastic Laminate Countertops: Medium density fiberboard substrate covered with HPDL, conventionally fabricated and self-edge banded.

2.05 ACCESSORIES

A. Adhesive: Type recommended by AWI/AWMAC to suit application.

B. Fasteners: Size and type to suit application.

C. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; stainless steel finish in concealed locations and stainless steel finish in exposed locations.

2.06 HARDWARE

A. Hardware: BHMA A156.9, types as recommended by fabricator for quality grade specified.

B. Adjustable Shelf Supports: Standard side-mounted system using multiple holes and coordinated rubber button fitted self rests, polished chrome finish, for nominal 1 inch (25 mm) spacing adjustments.
   1. Product: #346P ANO and #129 rubber cushion manufactured by Knapp & Vogt.

C. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers ("U" shaped wire pull, steel with chrome finish, 100 mm centers).

D. Catches: Magnetic.
   1. Product: #918 manufactured by Knape & Vogt.

E. Drawer Slides:
   1. Type: Full extension with overtravel.
   2. Static Load Capacity: Commercial grade.
   3. Mounting: Side mounted.
   4. Stops: Integral type.
   5. Features: Provide self closing/stay closed type.
   6. Manufacturers:
      a. Accuride International, Inc: www.accuride.com.
      b. Grass America Inc: www.grassusa.com.
      c. Knape & Vogt Manufacturing Company; Product #6505: www.kv.com.

F. Hinges: European style concealed self-closing type, steel with polished finish.
   1. Manufacturers:

a. Grass America Inc; Product #G100: www.grassusa.com.
b. Hardware Resources: www.hardwareresources.com.
c. Julius Blum, Inc: www.blum.com.
d. Substitutions: See Section 01600 - Product Requirements.

2.07 SITE FINISHING MATERIALS

A. Finishing: Site finished as specified in Section 09900.

2.08 FABRICATION

A. Cabinet Style: Flush overlay.

B. Cabinet Doors and Drawer Fronts: Flush style.

C. Drawer Construction Technique: Dovetail joints.

D. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.

E. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.

F. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.

G. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with largest manufactured sizes available. Fit corners and joints hairline; secure with concealed fasteners. Slightly bevel arises. Locate counter butt joints minimum 2 feet (600 mm) from sink cut-outs.
1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
2. Cap exposed plastic laminate finish edges with material of same finish and pattern.

H. Mechanically fasten back splash to countertops with steel brackets at 16 inches (400 mm) on center.

I. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Prime paint cut edges.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify adequacy of backing and support framing.

B. Verify location and sizes of utility rough-in associated with work of this section.

3.02 INSTALLATION

A. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units.

D. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch (1 mm). Do not use additional overlay trim for this purpose.

E. Secure cabinets to floor using appropriate angles and anchorages.

F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

3.03 ADJUSTING

A. Adjust installed work.

B. Adjust moving or operating parts to function smoothly and correctly.

3.04 CLEANING

A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION

SECTION 06610

GLASS FIBER FABRICATIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fiberglass reinforced plastic fabrications, assemblies, and appurtenant system components.

1.02 RELATED SECTIONS

A. Metal Fabrications: Section 05500

B. Aluminum Fabrications: Section 05600

1.03 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   2. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Manufacturer's design to comply with OSHA Specifications 1910.23, 1910.24, and all other applicable OSHA requirements.

1.05 SUBMITTALS

A. Product Data: Submit material manufacturer's published product descriptive data indicating following items:
   1. Minimum physical properties data and applicable descriptive test data for each product.
   2. Include pertinent installation instructions for prefabricated products.
   3. Submit certification that products comply with specified test data and/or referenced standards.

B. Shop Drawings: Submit Shop Drawings in accordance with Section 01300, demonstrating compliance with specifications.
   1. Clearly identify fiberglass items on Shop Drawings, and be complete as to detail of product and location in Project.
   2. Indicate size of members, joining methods, location, and type of anchors, and necessary installation reference measurements.

3. Indicate fabricated part numbers and their locations in the assembly.
4. Indicate mechanical properties of structural members.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle prefinished products in a manner that prevents material damage, deterioration, or contamination from elements.

B. Provide protective wrapping on prefinished products, if required, to prevent damage until Project is ready for final inspection.

C. See Section 01600 for general handling, storage and protection requirements.

PART 2 PRODUCTS

2.01 FIBERGLASS GRATINGS

A. Fiberglass Gratings (Pultruded): Fiberglass reinforced plastic pultruded bar type grating. Individual "T" or "I" bar shaped bearing bars assembled and bonded with tie bar components into a one piece panel of grating with a flush top tie bar design. Material to have Class 1 fire retardance rating of 25 or less per ASTM E84, meet self-extinguishing requirements of ASTM D635, and be corrosion resistant.
   1. Bearing Bars: Continuous glass fiber core wrapped by continuous glass mat and permanently bonded together with thermosetting resin plus synthetic surfacing veil.
   2. Tie Bar System: Two part mechanical locking pultruded cross rod with cross rod top flush with bearing bar top.
   3. Clip Assemblies: Type 316 stainless steel saddle and plate clips, bolts, nuts and washers as recommended by manufacturer.
   4. Resin System: Fire retardant vinyl ester.
   5. U.V. Resistance: U.V. resistant synthetic veil on all exposed surfaces.
   6. Anti-Skid: Provide grating with bearing bar and tie bar top surface covered with permanently bonded quartz/epoxy nonskid surface.
   7. Color: Gray.
   8. Design Data:
      a. "T" or "I" Bar Top Width: 1 inch
      b. Open Space Between Bars: 0.5 inch
      c. Depth: 2 inches.
   9. Acceptable Manufacturers:
      a. Fibergrate Composite Structures; Saf-T-Span, T-3320.
      b. Seasafe, Inc.; Safegrate.

B. Fiberglass Grating (Molded): Fiberglass reinforced composite molded grating with smooth mold surfaces. Bearing bars and cross bars of grating are molded at same time into a one piece construction.

1. Resin System: Premium grade vinyl ester resin with a tested flame spread of 25 or less utilizing ASTM E84 Tunnel Test.
2. Bearing and Cross Bars: Bi-directional bar construction manufactured by interweaving continuous glass filaments which are impregnated with a thermosetting resin.
3. Clip Assemblies: Type 316 stainless steel hold down and end panel clips, bolts, nuts and washers as recommended by manufacturer.
4. U.V. Resistance: Ultraviolet protection obtained by means of an inhibitor added to composite.
5. Anti-Skid: Provide grating with grit top surface on bearing and cross bars.
6. Color: Gray.
7. Grid Pattern: 1-1/2 x 1-1/2 inch square by 1-1/2 inch thick.
8. Embedment Angle:
   a. Fiberglass Angle: Reinforced fiberglass fabricated from pultruded structural shapes.
   b. Stainless Steel Angle: As specified in Section 05500.
9. Acceptable Manufacturers:
   a. Fibergrate Composite Structures; Molded Fiberglass Grating.
   b. Seasafe, Inc.; Gator-Grate.

2.02 FIBERGLASS STRUCTURAL SHAPES

A. Materials: Pultrusions consisting of fiberglass reinforcements and thermosetting ester resin systems.
   1. Provide materials which have Class I fire retardance rating of 25 or less per ASTM E 84, meet self-extinguishing requirements of ASTM D 635, and are corrosion-resistant.
   2. Resins: Vinyl Ester with a UV inhibitor.

B. Mechanical Properties: Provide the following minimum values:
   1. Ultimate tensile strength (longitudinal coupon): 30,000 psi
      a. Ultimate tensile strength (full section in bending): 30,000 psi
   2. Ultimate compressive strength (longitudinal coupon): 30,000 psi
      a. Ultimate compressive strength (full section in bending): 30,000 psi
   3. Ultimate shear strength: 4,500 psi
   4. Ultimate bearing strength: 30,000 psi
   5. Modulus of elasticity (full section in bending): 2.8×10^6 psi

C. Connections: Use fiberglass studs and hex nuts for all structural connections. Use adhesives only where indicated on Drawings.
   1. Acceptable Manufacturer:
      a. Fibrebolt; Strongwell.
      b. Superstud; Creative Pultrusions, Inc.
      c. Dynaform; Fibergrate Composite Structures

D. Acceptable Manufacturers:

1. EXTREN 625; Strongwell.
2. Pultex Series 1625; Creative Pultrusions, Inc.
3. Dynaform; Fibergrate Composite Structures

2.03 FIBERGLASS RAILING

A. Material: Fiberglass reinforced plastic (FRP) pultrusions using a synthetic surfacing veil for maximum chemical resistance.
   1. Material mechanical properties meet those given for Fiberglass Structural Shapes specified above.
   2. Fire Retardance: Provide materials with a Class I fire retardance rating of 25 or less per ASTM E84, meet self-extinguishing requirement of ASTM D635, and are corrosion resistant.
   3. Color: OSHA standard safety yellow.
   4. Dimensions: Nominal two inch square tube.

B. Acceptable Manufacturers:
   1. SAFRAIL; Strongwell.
   2. Dynarail; Fibergrate Composite Structures

2.04 FIBERGLASS LADDERS

A. Materials: Fiberglass reinforced plastic pultrusions meeting mechanical properties listed for Fiberglass Structural Shapes specified previously.
   1. Provide materials with a Class I fire retardance rating of 25 or less per ASTM E84, meet self-extinguishing requirements of ASTM D635, and are corrosion resistant.
   2. Side Rails and Rungs: Dimensions as noted on Drawing.
   3. Anti-Skid Surface: Provide top surface of rungs with a permanently bonded grit, baked epoxy, anti-skid surface.
   4. Color: OSHA Standard safety yellow.
   5. Ladder-Up Safety Post: Stainless steel device with telescoping tubular section that locks automatically when fully extended, as manufactured by the Bilco Company.

B. Acceptable Manufacturers:
   1. SAFRAIL; Strongwell.
   2. Dynarail; Fibergrate Composite Structures.

2.05 FABRICATION

A. Shop Fabrication: Do not proceed with fabrication until approved Shop Drawings are received by manufacturer.
   1. Provide prefabricated sections with required couplings, fasteners, holes, clips, and adhesives required to field assemble system.

2. Tag each component or panel part with manufacturer's drawing and part numbers for ease of installation.
3. Factory seal shop cut edges and holes with compatible resin system.
4. Use FRP dowels or stainless steel fasteners for all connections.

B. Insofar as possible, fit and shop assemble FRP fabrications, ready for installation.

C. Fabricate in accordance with details, approved shop drawings and reference standards.

D. Fabricate work square, plumb, straight and true.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect all items prior to placement. Repair or replace damaged items as directed by Engineer.

B. Inspect installed work of other trades and verify such work is complete to point where this work can properly commence.

3.02 INSTALLATION

A. Install fiberglass items in accordance with manufacturer's installation instructions and approved shop drawings.

B. Seal all edges cut during installation with compatible resin system.

END OF SECTION

SECTION 07130

SHEET WATERPROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Sheet membrane waterproofing.

B. accessories.

C. Drainage panels.

1.02 RELATED SECTIONS

A. Section 02316 - Fill and Backfill.

B. Section 03300-Cast-in-Place Concrete: Concrete substrate.

C. Section 02620-Subdrainage: Foundation drainage.

D. Section 07900 - Joint Sealers: Sealant for joints in substrates.

1.03 REFERENCES

A. ASTM D 412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers- Tension; 1998a (Reapproved 2002).

B. ASTM D 570 - Standard Test Method for Water Absorption of Plastics; 1998.

C. ASTM D 624 - Standard Test Method For Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers; 2000.

D. ASTM D 746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact; 2004.

E. ASTM D 2240 - Standard Test Method For Rubber Property--Durometer Hardness; 2005.

F. ASTM E 96/E 96M - Standard Test Methods For Water Vapor Transmission of Materials; 2005.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for membrane, surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants.

C. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

D. Certificate: Certify that products meet or exceed specified requirements.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Membrane Manufacturer Qualifications: Company specializing in waterproofing sheet membranes with ten years experience.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.06 MOCK-UP

A. Construct mockup 200 sq ft (10 sq m) of vertical waterproofed panel; to represent finished work including internal and external corners, seam jointing, attachment method, drainage panel, base flashings, and expansion joints.

B. Locate where directed.

C. Mockup may remain as part of the Work.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Maintain ambient temperatures above 40 degrees F (5 degrees C) for 24 hours before and during application and until liquid or mastic accessories have cured.

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for waterproofing failing to resist penetration of water, except where such failures are the result of structural failures of building. Hairline cracking of concrete due to temperature change or shrinkage is not considered a structural failure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Grace Construction Products; Product Bituthene 3000 www.na.graceconstruction.com.

B. Other Acceptable Laminated Composite Manufacturers:
1. W.R. Meadows, Inc; Product Mel-Rol: www.wrmeadows.com.
2. Substitutions: See Section 01600 - Product Requirements.

2.02 MEMBRANE MATERIALS

A. Sheet Waterproofing - General: Laminated composite membrane, self-adhered.
1. Capable of resisting water head of ____ feet (____ mm) and preventing moisture migration to interior.

B. Composite Laminate Membrane: Comprised of 1.4 mm thickness of polymeric membrane and a 0.1 mm thickness of carrier film; 1/16 inch (1.5 mm) total thickness.
1. Sheet Width: 36 inch (900 mm), minimum.

2. Tensile Strength: 5325 psi (36.74 MPa), measured in accordance with ASTM D 412.
3. Ultimate Elongation: 300 percent, measured in accordance with ASTM D 412.
4. Water Absorption: 0.1 percent increase in weight, maximum, measured in accordance with ASTM D 570, 24 hour immersion.
5. Water Vapor Permeability: 0.05 perm inch (2.9 gm/Pa/s/m), measured in accordance with ASTM E 96/E 96M.

C. Seaming Materials: As recommended by membrane manufacturer.

D. Membrane Sealant: As recommended by membrane manufacturer.

E. Termination Bars: Stainless steel; compatible with membrane and adhesives.

F. Surface Conditioner: ____ type, compatible with membrane.

G. Adhesives: As recommended by membrane manufacturer.

H. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

2.03 ACCESSORIES

A. Drainage Panel: 7/16 inch (19.5 mm) thick formed plastic, embossed with cover sheet; Mel-Drain #7055 manufactured by W. R. Meadows.
1. Other Acceptable Laminated Composite Manufacturers:
a. Grace Construction Products; Product Hydroduct: www.na.graceconstruction.com.
b. Tremco, Inc.; Product TREMDrain: www.tremcosealants.com.
c. Substitutions: See Section 01600 - Product Requirements.

B. Cant Strips: Premolded composition material, as shown on the drawings and as recommended by membrane manufacturer.

C. Flexible Flashings: Type recommended by membrane manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.

C. Verify items which penetrate surfaces to receive waterproofing are securely installed.

3.02 PREPARATION

A. Protect adjacent surfaces not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing in accordance with manufacturer's instructions. Vacuum substrate clean.

C. Do not apply waterproofing to surfaces unacceptable to membrane manufacturer.

D. Seal cracks and joints with sealant using depth to width ratio in accordance with Section 07900.

3.03 INSTALLATION - MEMBRANE

A. Install membrane waterproofing in accordance with manufacturer's instructions.

B. Roll out membrane. Minimize wrinkles and bubbles.

C. Self-Adhering Membrane: Remove release paper layer. Roll out on substrate with a mechanical roller to encourage full contact bond.

D. Overlap edges and ends and seal by method recommended by manufacturer, minimum 2 1/2 inches (63 mm). Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

E. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.

F. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.

G. Install flexible flashings. Seal items penetrating through membrane with flexible flashings. Seal watertight to membrane.

H. Seal membrane and flashings to adjoining surfaces. Install termination bar at all edges.

3.04 INSTALLATION - DRAINAGE PANEL

A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward. Scribe and cut boards around projections, penetrations, and interruptions.

3.05 SCHEDULE

A. Foundation Wall: One ply of CPE membrane waterproofing; three plies at inside corners; adhesive applied.

END OF SECTION

SECTION 07162

CRYSTALLINE WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provisions for furnishing all materials, thoroughly cleaning surfaces and performing application of concrete waterproofing at locations listed below.
   1. Inside face of clarifier basins exposed to an interior room space or exterior exposure.
   2. Inside face of filter walls opposite the filter pipe gallery, and filter walls with exterior exposure.
   3. Inside face of distributive pumping station walls below grade.

B. Related Sections:
   1. Submittals: Section 01300.

1.02 SUBMITTALS

A. Submit to the Engineer detailed, dimensioned shop drawings and data in accordance with the requirements of Section 01300 of the General Requirements. Do not undertake chemical concrete waterproofing work until the Owner has approved the submittals.

B. Submit evidence that all chemical concrete waterproofing materials are suitable and have been approved for use in potable water by the U.S. Environmental Protection Agency and any and all other applicable regulatory agencies.

PART 2 PRODUCTS

2.01 MATERIALS

A. Furnish a surface applied capillary waterproofing material which waterproofs by nonsoluble crystalline growth in the concrete substrate. All chemical concrete waterproofing materials shall be NSF 61 approved for contact with potable water.

B. Furnish VANDEX spray on Capillary Waterproofing Systems, or XYPEX Concentrate. Have the manufacturer of the chemical concrete waterproofing system furnish all materials, including materials required to properly prepare surface of concrete to receive waterproofing, in accordance with the concrete waterproofing manufacturer's recommendations.

PART 3 EXECUTION

3.01 GENERAL

A. Follow concrete waterproofing manufacturer's instructions throughout unless otherwise called for in these Specifications. Provide finished surfaces which are uniform. Provide drop cloths and other protection and avoid splattering on surface not required to receive chemical concrete waterproofing.

B. Store and mix concrete waterproofing at locations and in a manner approved by the Engineer. Store materials off the ground. Keep storage areas dry, not less than 45° F, clean and well ventilated. Remove empty containers and waste materials daily.

C. Deliver materials in unbroken original containers bearing the manufacturer and product names and special directions. Do not open containers until they have been inspected and approved by the Engineer and are required for use.

D. Tightly seal containers of surplus materials and deliver them to the Owner upon completion of work.

3.02 SURFACE PREPARATION

A. Thoroughly clean concrete surfaces to be treated. Remove all laitance, dirt, films, form scale, oil, form release agents, paint, coatings and other foreign matter. Acid etch, lightly abrasive blast, steam clean or water blast laitance and surfaces considered to be not absorbent enough to provide an open capillary system.

B. Repair structural defects such as cracks, faulty construction joints and honeycombing. Conform to the manufacturer's recommendations for repair of structural defects and for preparation of vertical and horizontal surfaces.

C. Examine concrete surface to be waterproofed and report unacceptable surface conditions to the Engineer. Do not commence application of concrete waterproofing until the surfaces to be waterproofed are satisfactory and have been approved by the Engineer and the manufacturer.

D. Prior to the application of concrete waterproofing, thoroughly moisten concrete surface to be waterproofed taking care to remove any excess surface water. The concrete waterproofing may be applied while the concrete subsurface is still "green", but not less than 24 hours after the concrete has been placed.

3.03 APPLICATION

A. Apply concrete waterproofing only when environmental conditions are in accordance with concrete waterproofing manufacturers requirements, temperatures are uniform at or above 40° F. for a minimum period of 48 hours before as well as during the application and drying or curing periods. In dry atmosphere, and when the area to

which the chemical concrete waterproofing is to be applied is clean and free from dust or other deleterious substances.

B. Provide workmen with goggles, rubber gloves and other protective wear and take all measures required to ensure safe and comfortable working conditions during application and throughout the work.

C. Mix all materials in conformance with manufacturer's recommendations and keep at uniform consistency during application.

3.04 CURING

A. Follow recommendations of the concrete waterproofing manufacturer for curing. Protect freshly treated surface from rain for not less than 24 hours after completion of application. Maintain temperatures above 40° F. for at least 3 days after completion of application. Apply a curing agent to the treated surfaces as soon as they are sufficiently dry. Allow treated surfaces to cure for not less than 16 days prior to filling tanks with liquid.

3.05 TESTING

A. After the curing and setting period, fill the tanks with water and check for watertightness. Correct any and all leakage which occurs. For corrective measures, conform to the manufacturer's recommendations. Repeat testing until all leaks are corrected.

END OF SECTION

SECTION 07212

BOARD AND BATT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Board insulation at perimeter foundation wall and underside of floor slabs where shown on the drawings.

1.02 RELATED SECTIONS

A. Section 07260 - Vapor Retarders: Separate air barrier and vapor retarder materials.

1.03 REFERENCES

A. ASTM C 578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2005a.

B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2005.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on product characteristics, performance criteria, and product limitations.

C. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.06 SEQUENCING

A. Sequence work to ensure fireproofing and firestop materials are in place before beginning work of this section.

1.07 COORDINATION

A. Coordinate the work with Section 07260 for installation of vapor retarder.

PART 2 PRODUCTS

2.01 APPLICATIONS

A. Insulation Under Concrete Slabs: Extruded polystyrene board.

2.02 BOARD INSULATION MATERIALS

A. Extruded Polystyrene Board Insulation: ASTM C 578, Type X; Extruded polystyrene board with either natural skin or cut cell surfaces; with the following characteristics:
   1. Flame Spread Index: 75 or less, when tested in accordance with ASTM E 84.
   2. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
   3. Board Size: 24 x 96 inch (610 x 2440 mm).
   4. Board Thickness: 2 inches (50 mm).
   5. Board Edges: Tongue-and-groove.
   6. Thermal Conductivity (k factor) at 25 degrees F (-3.9 degrees C): 0.18 (0.31).
   7. Compressive Resistance: 25 psi (173 kPa).
   8. Board Density: 1.6 lb/cu ft (26 kg/cu m).
   9. Water Absorption, maximum: 0.3 percent, volume.
   10. Manufacturers:
      a. Dow Chemical Co: www.dow.com.
      b. Owens Corning Corp: www.owenscorning.com.
      c. Pactiv Building Products: www.pactiv.com/green-guard/.
   11. Substitutions: See Section 01600 - Product Requirements.

2.03 ACCESSORIES

A. Sheet Vapor Retarder: Specified in Section 07260.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

3.02 BOARD INSTALLATION UNDER CONCRETE SLABS

A. Place insulation under slabs on grade after base for slab has been compacted.

B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.

END OF SECTION

SECTION 07540

THERMOPLASTIC MEMBRANE ROOFING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Adhered system with thermoplastic roofing membrane.

B. Insulation, flat and tapered.

C. Vapor retarder.

D. Flashings.

E. Roofing stack boots and walkway pads.

1.02 RELATED SECTIONS

A. Section 03415 - Precast Concrete Hollow Core Planks: Precast roof deck.

B. Section 06100 - Rough Carpentry: Wood nailers and curbs.

C. Section 07620 - Sheet Metal Flashing and Trim: Counterflashings, reglets, and metal drip edges.

D. Section 07710 - Roof Specialties and Accessories: Prefabricated copings.

E. Section 07720 - Roof Accessories: Roof-mounted units; prefabricated curbs.

F. Section 15146 - Plumbing Specialties: Roof drains.

G. Section 13100 - Lightning Protection.

1.03 REFERENCES

A. ASTM C 177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2004.

B. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2006.

C. ASTM D 6878 - Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing; 2003.

D. ASTM E 96/E 96M - Standard Test Methods for Water Vapor Transmission of Materials; 2005.

E. NRCA ML104 - The NRCA Roofing and Waterproofing Manual; National Roofing Contractors Association; Fifth Edition, with interim updates.

F. UL (RMSD) - Roofing Materials and Systems Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data indicating membrane materials, flashing materials, insulation, and fasteners.

C. Specimen Warranty: For approval.

D. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.

E. Samples for Verification: Submit two samples 4 x 4 inches (____x____ mm) in size illustrating insulation.

F. Manufacturer's Installation Instructions: Indicate membrane seaming precautions and perimeter conditions requiring special attention.

G. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

H. Manufacturer's Field Reports: Indicate procedures followed, ambient temperatures, humidity, wind velocity during application, and supplementary instructions given.

I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

B. Installer Qualifications: Company specializing in performing the work of this section:
   1. With minimum five (5) years documented experience.
   2. Approved by membrane manufacturer.

1.06 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

B. Review preparation and installation procedures and coordinating and scheduling required with related work.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.

B. Store products in weather protected environment, clear of ground and moisture.

C. Protect foam insulation from direct exposure to sunlight.

1.08 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
   1. Warranty Term: 20 years.
   2. For repair and replacement include costs of both material and labor in warranty.
   3. Exceptions NOT Permitted:

a. Damage due to roof traffic.
b. Damage due to wind of speed greater than 56 mph (90 km/h) but less than 90 mph (145 km/h).

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermoplastic Polyolefin Membrane Materials:
1. Carlisle SynTec Incorporated; Sure-Weld: www.carlisle-syntec.com.
2. Firestone Building Products Co; UltralPly TPO: www.firestonebpco.com.
3. Versico Roofing Systems; VersiWELD: www.versico.com.
4. Substitutions: See Section 01600 - Product Requirements.

B. Insulation:
1. Carlisle Syn Tec Systems, Division of Carlisle Corporation; Polyisocyanurate HP: www.carlisle-syntec.com.
2. Atlas Roofing Corporation: AC-Foam III: www.atlasroofing.com.
3. Dow Chemical Co: www.dow.com.
4. Versico Roofing Insulation; MP- H: www.versico.com.
5. Schuller Roofing Insulation; ENRGY 2: www..
6. Substitutions: See Section 01600 - Product Requirements.

2.02 ROOFING - UNBALLASTED APPLICATIONS

A. Thermoplastic Membrane Roofing: One ply membrane, fully adhered, over insulation.

B. Roofing Assembly Requirements:
1. Roof Covering External Fire-Resistance Classification: UL Class A.
2. All components of the approved roofing system (including insulation, adhesive(s), vapor retarder, edge/cap flashing, fasteners and fastening plates) shall be products of the approved manufacturer or accepted by the approved roofing manufacturer as compatible and covered by the warranty..

C. Acceptable Insulation Types - Constant Thickness Application: Clearwell roof only
1. Bottom layer of polyisocyanurate board covered with a second layer of polyisocyanurate board.

D. Acceptable Insulation Types - Tapered Application: All roofs except Clearwell roof.
1. Uniform thickness polyisocyanurate boards, number as required to achieve slope, covered with tapered polyisocyanurate board.

2.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

A. Membrane:
1. Material: Thermoplastic polyolefin (TPO) complying with ASTM D 6878.
2. Reinforcing: Internal fabric.
3. Thickness: 0.60 inch (1.46 mm), minimum.
4. Sheet Width: Factory fabricated into largest sheets possible.
5. Color: White.

B. Seaming Materials: As recommended by membrane manufacturer.

C. Vapor Retarder: Reinforced Kraft paper laminate; compatible with roofing and insulation materials.
   1. Fire-retardant adhesive.
   2. Vapor permeability: 0.02 perm inch (_____ ng/(Pa s m)), measured in accordance with ASTM E 96/E 96M.
   3. Product: 2835M manufactured by Lamotite, Division of Rexham Corp.

D. Flexible Flashing Material: Same material as membrane.

2.04 INSULATION

A. Polyisocyanurate Board Insulation: Rigid cellular foam, complying with ASTM C 1289, Type II, Class 2, polymer bonded glass fiber mat both faces and with the following characteristics:
   1. HCFC free insulation in compliance with the US EPA requirements of January 1, 2003.
   2. Flame Spread Index: 25, when tested in accordance with ASTM E 84.
   3. Compressive Strength: 20 psi (138 kPa)
   4. Board Size: 48 x 48 inch (1220 x 1220 mm).
   5. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E 84.
   6. Thermal Conductivity (k factor): 0.167 (0.29) as determined by ASTM C 177.
   7. Board Density: 1.65 lb/cu ft (24 kg/cu m).
   8. Dimensional Stability: less than 2 percent linear change.
   9. Tapered Board: Slope as indicated; minimum thickness 1/2 in (13 mm); fabricate total insulation combination of tapered and single thickness boards of fewest layers possible.
   10. Board Edges: Square.
   11. Manufacturer: Atlas Roofing Corporation: Product: ACFoam III; www.atlasroofing.com.
   12. Acceptable Manufacturers:
      a. Carlisle Syn Tec Systems, Division of Carlisle Corporation; Polyisocyanurate HP: www.carlisle-syntec.com.
      b. Dow Chemical Co: www.dow.com.
      c. GAF Materials Corporation: www.gaf.com.
      d. _____.
      e. Substitutions: See Section 01600 - Product Requirements.

2.05 ACCESSORIES

A. Prefabricated Roofing Expansion Joint Flashing: As specified in Section 07710.

B. Stack Boots: Prefabricated flexible boot and collar for pipe stacks through membrane; same material as membrane.

C. Insulation Joint Tape: Glass fiber reinforced type as recommended by insulation manufacturer, compatible with roofing materials; 6 inches (150 mm) wide; self adhering.

D. Membrane Adhesive: As recommended by membrane manufacturer.

E. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.

F. Thinners and Cleaners: As recommended by adhesive manufacturer, compatible with membrane.

G. Insulation Adhesive: As recommended by insulation manufacturer.

H. Strip Reglet Devices: Galvanized steel, maximum possible lengths per location, with attachment flanges.

I. Sealants: As recommended by membrane manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Perform work in accordance with NRCA Roofing and Waterproofing Manual and manufacturer's instructions.

B. Do not apply roofing membrane during unsuitable weather.

C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.

D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

F. Coordinate the work with installation of associated counterflashings installed by other sections as the work of this section proceeds.

3.02 EXAMINATION

A. Verify that surfaces and site conditions are ready to receive work.

B. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.

C. Verify deck surfaces are dry and free of snow or ice.

D. Verify that roof openings, curbs, and penetrations through roof are solidly set, and reglets are in place.

3.03 CONCRETE DECK PREPARATION

A. Verify adjacent precast concrete roof members do not vary more than 1/4 inch (6 mm) in height. Verify grout keys are filled flush.

B. Fill surface honeycomb and variations with latex filler.

C. Confirm dry deck by moisture meter with 12 percent moisture maximum.

3.04 INSULATION - UNDER MEMBRANE

A. Apply vapor retarder to deck surface with adhesive in accordance with manufacturer's instructions.
   1. Install flexible flashing from vapor retarder to air seal material of wall construction, lap and seal to provide continuity of the air barrier plane.

B. Ensure vapor retarder is clean and dry, continuous, and ready for application of insulation.

C. Attachment of Insulation: Embed each layer of insulation in adhesive in full contact, in accordance with roofing and insulation manufacturers' instructions.

D. Lay subsequent layers of insulation with joints staggered minimum 6 inch (150 mm) from joints of preceding layer.

E. Place tapered insulation to the required slope pattern in accordance with manufacturer's instructions.

F. Lay boards with edges in moderate contact without forcing. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof. Keep insulation a minimum of 3 inches (75 mm) from heat emitting devices and a minimum of 2 inches (50 mm) from sidewalls of Type A chimneys and Type B and L vents.

G. Tape joints of insulation in accordance with roofing and insulation manufacturers' instructions.

H. At roof drains, use factory-tapered boards to slope down to roof drains over a distance of 18 inches (450 mm).

I. Do not apply more insulation than can be covered and sealed with membrane in same day.

3.05 MEMBRANE APPLICATION

A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.

B. Shingle joints on sloped substrate in direction of drainage.

C. Fully Adhered Application: Apply adhesive to substrate at rate of 0.59 gal/square (____ L/sq m). Fully embed membrane in adhesive except in areas directly over or within 3 inches (75 mm) of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.

D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches (75 mm). Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

E. At intersections with vertical surfaces:
   1. Extend membrane up a minimum of 4 inches (100 mm) onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and over top of parapet or up to counter flashing and reglets as shown on the drawings.
   3. Insert flashing into reglets and secure.

F. Around roof penetrations, seal flanges and flashings with flexible flashing.

G. Install roofing expansion joints where indicated. Make joints watertight.
   1. Install prefabricated joint components in accordance with manufacturer's instructions.

H. Coordinate installation of roof drains and related flashings.

3.06 FINISHING UNBALLASTED SURFACES

A. Install walkway pads. Space pad joints to permit drainage.

3.07 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for general requirements for field quality control and inspection.

B. Require site attendance of roofing and insulation material manufacturers daily during installation of the Work.

3.08 CLEANING

A. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.

B. Repair or replace defaced or damaged finishes caused by work of this section.

3.09 PROTECTION OF FINISHED WORK

A. Protect installed roofing and flashings from construction operations.

B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION

SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fabricated sheet metal items, including metal drip edges, reglet frames, counterflashings and roof edge termination/fascia.

B. Scuppers.

1.02 RELATED SECTIONS

A. Section 04810-Unit Masonry Assemblies: Through-wall flashings in masonry.

B. Section 07540-Thermoplastic Membrane Roofing: Roofing system.

C. Section 07710 - Manufactured Roof Specialties: Preformed flashings and manufactured expansion joint covers.

D. Section 07900 - Joint Sealers.

E. Section 09900 - Paints and Coatings: Field painting.

1.03 REFERENCES

A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.

B. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.

C. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2004.

D. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2004.

E. ASTM D 2178 - Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing; 2004.

F. ASTM D 4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free; 2000.

G. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2003.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.

B. Maintain one copy of each document on site.

C. Fabricator and Installer Qualifications: Company specializing in sheet metal work with 3 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

B. Prevent contact with materials which may cause discoloration or staining.

1.07 PROJECT CONDITIONS

A. Coordinate with the work ofSection 07540 for the installation of metal drip edges, reglet frames, roof edge termination/fascias and counter flashing.

PART 2 PRODUCTS

2.01 SHEET MATERIALS

A. Pre-Finished Aluminum: ASTM B 209 (ASTM B 209M); 0.050 inch (1.27 mm) thick; plain finish shop pre-coated with fluoropolymer coating of color as selected.
   1. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system; color as selected from manufacturer's standard colors on approved shop drawings.

B. Stainless Steel: ASTM A 666 Type 304, soft temper, 0.015 inch (0.4 mm) thick; smooth No. 4 finish.

2.02 ACCESSORIES

A. Fasteners: Stainless steel, with soft neoprene washers.

B. Primer: Zinc chromate type.

C. Protective Backing Paint: Zinc molybdate alkyd.

D. Sealant: Type as specified in Section 07900.

E. Plastic Cement: ASTM D 4586, Type I.

F. Roof Edge Termination/Fascias: Aluminum, minimum exterior fascia dimension of 4 3/4", maximum cant height of 1/8" with continuous cleat; MBED-B475 Type-B (Box) manufactured by W.P.Hickmann Company.

G. Metal Drip Edges: Stainless steel; depth as shown on drawings with 3/4" front drip with hemmed edge, 3/4" vertical edge in back where shown on drawings and, where required, 3" high end dams.

H. Scuppers: Through-Parapet type, stainless steel; according to SMACNA Figure 1-30A with adjustments for bottom being flush with top of insulation; Thru-Wall Scupper manufactured by Metal-Era Inc..

I. Counter Flashing and Reglet Frames: Surface mounted type, stainless steel; face and ends covered with plastic tape; RC-1 manufactured by MM Systems Corp..

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch (13 mm); miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.

3.02 PREPARATION

A. Install surface mounted reglets true to lines and levels. Seal top of reglets with sealant.

B. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil (0.4 mm).

3.03 INSTALLATION

A. Secure reglet frames and counter flashings in place using exposed fasteners.

B. Apply plastic cement compound between metal flashings and felt flashings.

C. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.

D. Seal metal joints watertight.

3.04 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for field inspection requirements.

B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.

END OF SECTION

SECTION 07710

MANUFACTURED ROOF SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Manufactured roof specialties, including copings.

B. Roof expansion joint covers.

1.02 RELATED SECTIONS

A. Section 07540 - Thermoplastic Membrane Roofing: TPO roofing and flashing.

B. Section 07900 - Joint Sealers.

1.03 REFERENCES

A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.

B. SMACNA (ASMM) - Architectural Sheet Metal Manual; Sheet Metal and Air Conditioning Contractors' National Association; 2003.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on shape of components, materials and finishes, anchor types and locations.

C. Shop Drawings: Indicate configuration and dimension of components, adjacent construction, required clearances and tolerances, and other affected work.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual details.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Copings:
1. Architectural Products Co; Product Snap-Tight: www.archprod.com.
2. W.P. Hickman Co; Product Permasnap: www.wph.com.
3. MM Systems Corp; Product Snap-Lok: www.mmsystemscorp.com.
4. Tremco, Inc.; Product Trem-Lock.
5. Substitutions: See Section 01600 - Product Requirements.

B. Elastomeric Expansion Joint Covers:
1. GAF Materials Corporation; Product Metalastic: www.gaf.com.
2. Johns Manville Corporation; Product Expand-O-Flash: www.jm.com.
3. MM Systems Corp; Product ERF: www.mmsystemscorp.com.

4. Substitutions: See Section 01600 - Product Requirements.

2.02 COMPONENTS

A. Copings: Formed 5005-H34 alloy aluminum, 0.063 inch (1.6 mm) thick, shaped as indicated, including special supports spaced at 36 inches (900 mm) on center maximum, closer if required in manufacturer's installation instructions. Include continuous cleats on the face opposite the roof, stainless steel screws on the roof side at maximum 24" oc in pre-punched slotted or oversized holes with watertight, compressible washers, cover plates (minimum 6" wide) and backup plates (minimum 12" wide), to conceal and weather seal joints (including slip joints in copings at maximum 10'-0" oc) and attachment flanges. Supply coping with butyl strips to form an internal gutter system. Provide one-piece, watertight corners and exposed ends with welded seams.
   1. Finish: Smooth, Fluoropolymer coating (High Performance), multiple coat application.
   2. Color: As selected on approved shop drawings from manufacturer's full line of standard colors.

B. Elastomeric Expansion Joint Covers: Composite construction of ____ inch (____ mm) wide flexible EPDM flashing of white color with closed cell urethane foam backing, each edge seamed to aluminum sheet metal flanges, designed for nominal joint width of 1 inch (25 mm). Include special formed corners, tees, intersections, and wall flashings, each sealed watertight.

2.03 ACCESSORIES

A. Sealant: Type as as specified in Section 07900.

2.04 FINISHES

A. Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system; color as selected from manufacturer's standard colors on approved shop drawings.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that deck, curbs, roof membrane, base flashing, and other items affecting work of this Section are in place and positioned correctly.

3.02 INSTALLATION

A. Install components in accordance with manufacturer's instructions.

B. Coordinate installation of components of this section with installation of roofing membrane and base flashings.

C. Coordinate installation of sealants and roofing cement with work of this section to ensure water tightness.

END OF SECTION

SECTION 07720

ROOF ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Roof hatches.

1.02 RELATED SECTIONS

1.03 REFERENCES

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

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.
   4. Maintenance requirements.

1.05 DELIVERY, STORAGE, AND PROTECTION

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store products under cover and elevated above grade.

PART 2 PRODUCTS

2.01 ROOF HATCHES

A. Manufacturers - Roof Hatches:
   1. Bilco CoS-50: www.bilco.com.
   2. Dur-Red Products: www.dur-red.com.
   3. Milcor Inc: www.milcorinc.com.
   4. Substitutions: See Section 01600 - Product Requirements.

B. Roof Hatches: Factory-assembled aluminum frame and cover, complete with operating and release hardware.
   1. Style: Provide flat metal covers unless otherwise indicated.
   2. Mounting: Provide frames and curbs suitable for mounting on flat roof deck.
   3. Size(s): As indicated on drawings; single-leaf style unless indicated as double-leaf.
   4. For Ladder Access: Single leaf; 30 by 36 inches (762 by 914 mm).

C. Frames/Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
   1. Material: Mill finished aluminum, 11 gage, 0.125 inch (3 mm) thick.
   2. Insulation: 1 inch (25 mm) rigid glass fiber, located on inside hollow curb.
   3. Curb Height: 12 inches (305 mm) from finished surface of roof, minimum.

D. Metal Covers: Flush, insulated, hollow metal construction.

1. Capable of supporting 40 psf (1.92 kPa) live load.
2. Material: Mill finished aluminum; outer cover 0.125 inch (3 mm) thick, liner 0.04 inch (1.0 mm) thick.
3. Insulation: 1 inch (25 mm) rigid glass fiber.
4. Gasket: Neoprene, continuous around cover perimeter.

E. Accessories:
1. Ladder Safety Post: Install on fixed ladder(s) below hatch cover(s), LadderUP® safety post Model LU-4 as manufactured by The Bilco Company or approved equal. Device shall be mill finished aluminum. It shall be designed with a telescoping tubular section that locks automatically when fully extended. Upward and downward movement shall be controlled by a stainless steel spring balancing mechanism. Unit shall be completely assembled with fasteners for securing to the ladder rungs in accordance with the manufacturer's instructions.
2. Roof Hatch Safety Railing System: Provide the KeeHatch Railing System, Model RHSR-SS as manufactured by The Nesea Company or approved equal. Device shall be mill finished aluminum and mounted on the sides of the hatch curb. It shall meet OSHA Standards 29 CFR 1910.23 and 29 CFR 1910.27. Provide a swing gate at the opening from the railing manufacturer. Unit shall include all fittings required for securing to the hatch in accordance with the manufacturer's instructions.

F. Hardware: Type 316 stainless steel, unless otherwise indicated or required by manufacturer.
1. Lifting Mechanisms: Compression spring operator with shock absorbers that automatically opens up on release of latch; capable of lifting covers despite 10 psf (475 kPa) load.
2. Hinges: Heavy duty pintle type.
3. Hold open arm with vinyl-coated handle for manual release.
4. Latch: Upon closing, engage latch automatically and reset manual release.
5. Manual Release: Pull handle on interior.
6. Locking: Padlock hasp on interior.

PART 3 EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

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

A. Install in accordance with manufacturer's instructions, in manner that maintains roofing weather integrity.

3.04 CLEANING AND PROTECTION

A. Clean installed work to like-new condition.

B. Protect installed products until completion of project.

C. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 08331

OVERHEAD COILING DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overhead coiling doors, operating hardware, non-fire-rated and exterior, electric operation.

B. Wiring from electric circuit disconnect to operator to control station.

1.02 RELATED SECTIONS

A. Section 08710 - Door Hardware: Cylinder cores and keys.

B. Section 09900 - Paints and Coatings: Field paint finish.

C. Section 16155 - Equipment Wiring: Power to disconnect.

D. Section 16131 - Conduit: Conduit from electric circuit to operator and from operator to control station.

1.03 REFERENCES

A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2005a.

B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association; 2003.

C. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC; National Electrical Manufacturers Association; 2000 (R2005).

D. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2006.

E. UL (EAUED) - Electrical Appliance and Utilization Equipment Directory; Underwriters Laboratories Inc.; current edition.

1.04 QUALITY ASSURANCE

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Overhead Coiling Doors:
   1. The Cookson Company; Product FMWI 20: www.cooksondoor.com.
   2. Wayne-Dalton Corporation; Product Series 800C: www.waynedalton.com.
   3. Overhead Door Company; Product 625 Series.
   4. Raynor Worldwide; Product DuraCoil Standard.

5. Substitutions: See Section 01600 - Product Requirements.

2.02 COILING DOORS

A. Exterior Coiling Doors: Steel slat curtain.
   1. Capable of withstanding positive and negative wind loads of 20 psf (940 Pa), without undue deflection or damage to components.
   2. Sandwich slat construction with insulated core of polyurethane or polyisocyanurate type insulation; minimum insulation value: R of 6.29 (RSI of ____).
   3. Nominal Slat Size: 3 inches (75 mm) wide x required length.
   4. Finish: Factory painted powdercoat finish, color as selected on the approved shop drawings from the manufacturer's full range of colors.
   5. Guides: Angles; galvanized steel.
   6. Hood Enclosure: As indicated in these specifications under Materials, including waterproof canvas lintel/hood weatherseal; primed steel.
   7. Electric operation.
   8. Mounting: Surface mounted.

2.03 MATERIALS

A. Curtain Construction: Interlocking slats.
   1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
   2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position.
   3. Weatherstripping: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors. In addtion to the standard weatherstripping, provide brush guides at jambs and a waterproof canvas hood baffle.

B. Steel Slats: Minimum 20 gage (0.91 mm) ASTM A 653/A 653M galvanized steel sheet.
   1. Galvanizing: Minimum G90/Z275 coating.

C. Steel Guides: Formed from galvanized steel sheet, 6 gage (____ mm thick); 3 inch wide; complying with ASTM A 653/A 653M.
   1. Galvanizing: Minimum G90/Z275 coating.
   2. Prime paint.

D. Hood Enclosure: Internally reinforced to maintain rigidity and shape.
   1. Minimum 24 gage (0.061 mm thick).
   2. Prime paint.

E. Hardware:
   1. Lock Cylinders: Specified in Section 08710.
   2. Latching: Inside mounted, adjustable keeper, spring activated latch bar with feature to keep in locked or retracted position.
   3. Latch Handle: Interior handle.

F. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb (10 kg) nominal force to operate.

2.04 ELECTRIC OPERATION

A. Electric Operators:
   1. Mounting: Side mounted.
   2. Motor Enclosure:
      a. Exterior doors: NEMA MG 1 Type 4; open drip proof.
   3. Motor Rating: 1 hp (____ W); continuous duty.
   4. Motor Voltage: 240 volt, single phase, 60 Hz.
   5. Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
   6. Controller Enclosure: NEMA 250 Type 1.
   7. Opening Speed: 12 inches per second (300 mm/s).
   8. Brake: Adjustable friction clutch type, activated by motor controller.
   9. Manual override in case of power failure.

B. Control Station: Standard three button (OPEN-STOP-CLOSE) constant pressure control for each operator.
   1. 24 volt circuit.
   2. Surface mounted.

C. Safety Edge: Located at bottom of curtain, full width, electro-mechanical sensitized type, wired to stop operator upon striking object, hollow neoprene covered.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

C. Securely and rigidly brace components suspended from structure.

D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

E. Coordinate installation of electrical service with Section 16155.

F. Complete wiring from disconnect to unit components.

G. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.

H. Install perimeter trim and closures.

3.03 ERECTION TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch (1.5 mm).

C. Maximum Variation From Level: 1/16 inch (1.5 mm).

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft (3 mm per 3 m) straight edge.

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION

SECTION 08334

COILING COUNTER DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Fire-rated coiling counter doors and operating hardware.

1.02 RELATED SECTIONS

A. Section 08710 - Door Hardware: Cylinder cores and keys.

1.03 REFERENCES

A. ASTM A 666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2003.

B. ITS (DIR) - Directory of Listed Products; Intertek Testing Services NA, Inc.; current edition.

C. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association; 2007.

D. UL (BMD) - Building Materials Directory; Underwriters Laboratories Inc.; current edition.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Submit manufacturer's standard literature showing materials and details of construction and finish.

C. Shop Drawings: Indicate rough and actual opening dimensions, anchorage methods, hardware locations, and installation details.

D. Samples: Submit two slats, 4 inches long (100 mm long) illustrating shape, color and finish texture.

E. Manufacturer's Instructions: Indicate installation sequence and installation, adjustment, and alignment procedures.

F. Operation and Maintenance Data: Indicate modes of operation, lubrication requirements and frequency, and periodic adjustments required.

G. Project Record Documents: Include as-built electrical diagrams for electrical operation and connection to fire alarm system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Coiling Counter Doors:
   1. Alpine Overhead Doors, Inc; Product _____: www.alpinedoors.com.

2. _____; Product ____.
3. Substitutions: See Section 01600 - Product Requirements.

2.02 COILING COUNTER DOORS

A. Coiling Counter Doors, Fire-Rated: Stainless steel slat curtain.
1. Mounting: Interior face mounted.
2. Provide integral frame and sill of same material and finish.
3. Fire Rating: 1-1/2 hour; comply with NFPA 80.
a. Provide product listed and labeled by UL or ITS (Warnock Hersey) as suitable for the purpose specified and indicated.
4. Nominal Slat Size: 1-1/4 inches (32 mm) wide.
5. Slat Profile: Flat.
6. Finish: No. 4.
7. Guides: Formed track; same material and finish unless otherwise indicated.
8. Hood: As indicated; primed steel.
9. Fire Release Mechanism: Automatically self-closing with governed closing speed, actuated by manufacturer's standard fusible link.

2.03 MATERIALS

A. Curtain Construction: Interlocking, single thickness slats.
1. Slat Ends: Alternate slats fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
2. Curtain Bottom: Fitted with angles to provide reinforcement and positive contact in closed position; neoprene astragal along bottom edge.
3. Stainless Steel Slats: ASTM A 666, Type 304; minimum thickness 20 gage, 0.04 inch (0.9 mm).

B. Guide Construction: Continuous, of profile to retain door in place, with mounting brackets of same metal.
1. Stainless Steel Guides: ASTM A 666, Type 304, rollable temper.

C. Hood Enclosure: Internally reinforced to maintain rigidity and shape.

D. Latching: Inside mounted, sliding deadbolt.

E. Roller Shaft Counterbalance: Steel pipe and torsion steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb (10 kg) nominal force to operate.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that opening sizes, tolerances and conditions are acceptable.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.

B. In addition, install fire-rated doors in accordance with NFPA 80.

C. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.

D. Securely and rigidly brace components suspended from structure.

E. Fit and align assembly including hardware; level and plumb, to provide smooth operation.

F. Complete wiring from fire alarm system .

G. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.

3.03 ERECTION TOLERANCES

A. Maintain dimensional tolerances and alignment with adjacent work.

B. Maximum Variation From Plumb: 1/16 inch (1.5 mm).

C. Maximum Variation From Level: 1/16 inch (1.5 mm).

D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 ft (3 mm per 3 m) straight edge.

3.04 ADJUSTING

A. Adjust operating assemblies for smooth and noiseless operation.

3.05 CLEANING

A. Clean installed components.

B. Remove labels and visible markings.

END OF SECTION

SECTION 08360

OVERHEAD DOORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Overhead sectional doors, electrically operated.

B. Operating hardware and supports.

C. Electrical controls.

1.02 RELATED SECTIONS

A. Section 05500 - Metal Fabrications: Steel channel opening frame.

B. Section 07900 - Joint Sealers: Perimeter sealant and backup materials.

C. Section 08710 - Door Hardware: Lock cylinders.

D. Section 15065 - Motors for Mechanical Equipment.

E. Section 16131 - Conduit: Empty conduit from control units to door operator.

F. Section 16155 - Equipment Wiring.

1.03 REFERENCES

A. ASTM A 653/A 653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2005a.

B. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference; 2002.

C. DASMA 102 - American National Standard Specifications for Sectional Overhead Type Doors; Door & Access Systems Manufacturers' Association, International; 2004.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.

C. Product Data: Show component construction, anchorage method, and hardware.

D. Samples: Submit two panel finish samples, 4 x 4 inch (____x____ mm) in size, illustrating color and finish.

E. Manufacturer's Installation Instructions: Include any special procedures required by project conditions.

F. Operation Data: Include normal operation, troubleshooting, and adjusting.

G. Maintenance Data: Include data for motor and transmission, shaft and gearing, lubrication frequency, spare part sources.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.

B. Installer: Company specializing in performing the work of this section approved by manufacturer.

C. Conform to applicable code for motor and motor control requirements.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified.

1.06 WARRANTY

A. Correct defective Work within a five year period after Date of Substantial Completion.

B. Warranty: Include coverage for electric motor and transmission.

C. Provide five year manufacturer warranty for electric operating equipment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Wayne-Dalton Corporation; Product TS 200-20.

B. Other Acceptable Manufacturers:
1. Clopay Building Products Company, Inc: www.clopaydoor.com.
2. Overhead Door Corp.; Product Thermacore II.
3. Raynor.
4. Substitutions: See Section 01600 - Product Requirements.

2.02 STEEL DOOR COMPONENTS

A. Steel Doors: Flush steel, insulated; standard lift operating style with track and hardware; complying with DASMA 102, Commercial application.
1. Performance: Withstand positive and negative wind loads equal to 1.5 times design wind loads specified by local code without damage or permanent set, when tested in accordance with ASTM E 330, using 10 second duration of maximum load.
2. Door Nominal Thickness: 1-3/4 inches (45 mm) thick with additional 1 3/4" deep struts, minimum 2 per panel, for rigidity.
3. Exterior Finish: Pre-finished with silicone polyester of color as selected.
4. Interior Finish: Pre-finished with silicone polyester of color as selected on approved shop drawings from the manufacturer's full range of colors.

5. Glazed Lights: Four, 24" x 6" glazed lights per panel, one row; set in place with resilient glazing channel.
6. Operation: Electric.

B. Door Panels: Flush steel construction; outer steel sheet of 0.0359 inch (0.91 mm) thick, v-grooved profile; inner steel sheet of 0.0359 inch (0.91 mm) thick, flat profile; core reinforcement of ____ inch (___ mm) thick sheet steel roll formed to channel shape, rabbeted weather joints at meeting rails; insulated.

C. Glazing: Type _____ specified in Section 08800.

2.03 DOOR COMPONENTS

A. Track: Rolled galvanized steel, 0.0673 inch (1.71 mm) thick; 2 inch (50 mm) wide, continuous one piece per side; galvanized steel mounting brackets 1/4 inch (6 mm) thick.

B. Hinge and Roller Assemblies: Heavy duty hinges and adjustable roller holders of galvanized steel; floating hardened steel bearing rollers, located at top and bottom of each panel, each side.

C. Lift Mechanism: Torsion spring on cross head shaft, with braided galvanized steel lifting cables.
1. For Manual Operation: Requiring maximum exertion of 25 lbs (110 N) force to open.

D. Sill Weatherstripping: Resilient hollow vinyl strip, one piece; fitted to bottom of door panel, full length contact.

E. Jamb Weatherstripping: Roll formed steel section full height of jamb, fitted with resilient weatherstripping, placed in moderate contact with door panels.

F. Head Weatherstripping: EPDM rubber seal, one piece full length and resilient air baffle in hood.

G. Panel Joint Weatherstripping: Neoprene foam seal, one piece full length to provide thermal break for panel.

H. Lock: Inside center mounted, adjustable keeper, spring activated latch bar with feature to retain in locked or retracted position; interior and exterior handle.

I. Lock Cylinders: Master keyed to building keying system.

2.04 MATERIALS

A. Sheet Steel: Hot-dipped galvanized steel sheet, ASTM A 653/A 653M, with G90/Z275 coating, plain surface.

B. Insulation: Foamed-in-place, CFC polyurethane, bonded to facing.
1. R value of 17.59 (RSI value of ____).
2. Same thickness as core framing members.

C. Metal Primer Paint: Zinc molybdate type.

2.05 ELECTRICAL OPERATION

A. Electrical Characteristics:
   1. 1/2 hp (375 W); manually operable in case of power failure, transit speed of 12 inches (300 mm) per second.
   2. 120 volts, single phase, 60 Hz.
   3. Refer to Section 16155 - Equipment Wiring: Electrical connections.

B. Motor: Comply with requirements of Section 15065.

C. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

D. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 16155.

E. Electric Operator: Side mounted on cross head shaft, adjustable safety friction clutch; brake system actuated by independent voltage solenoid controlled by motor starter; enclosed gear driven limit switch; enclosed magnetic cross line reversing starter; mounting brackets and hardware.

F. Safety Edge: At bottom of door panel, full width; electro-mechanical sensitized type, wired to stop door upon striking object; hollow neoprene covered to provide weatherstrip seal.

G. Control Station: Standard three button (open-close-stop) momentary type control for each electric operator.
   1. 24 volt circuit.
   2. Surface mounted.
   3. Locate at inside door jamb.

H. Hand Held Transmitter: Digital control, resettable.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

B. Verify that electric power is available and of the correct characteristics.

3.02 PREPARATION

A. Prepare opening to permit correct installation of door unit to perimeter air and vapor barrier seal.

3.03 INSTALLATION

A. Install door unit assembly in accordance with manufacturer's instructions.

B. Anchor assembly to wall construction and building framing without distortion or stress.

C. Securely brace door tracks suspended from structure. Secure tracks to structural members only.

D. Fit and align door assembly including hardware.

E. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07900.

3.04 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 1/16 inch (1.5 mm).

B. Maximum Variation from Level: 1/16 inch (1.5 mm).

C. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch (3 mm) from 10 ft (3 m) straight edge.

D. Maintain dimensional tolerances and alignment with adjacent work.

3.05 ADJUSTING

A. Adjust door assembly for smooth operation and full contact with weatherstripping.

B. Have manufacturer's field representative present to confirm proper operation and identify adjustments to door assembly for specified operation.

3.06 CLEANING AND PROTECTION

A. Clean doors, frames and glazing.

B. Remove temporary labels and visible markings.

C. Do not permit construction traffic through overhead door openings after adjustment and cleaning.

END OF SECTION

SECTION 08410

METAL-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Aluminum-framed storefront, with vision glass.

B. Aluminum doors and frames.

C. Weatherstripping.

D. Door hardware.

1.02 RELATED SECTIONS

A. Section 07900 - Joint Sealers: Perimeter sealant and back-up materials.

B. Section 08520 - Aluminum Windows: Operable sash within glazing system.

C. Section 08710 - Door Hardware: Hardware items other than specified in this section.

D. Section 08800 - Glazing: Glass and glazing accessories.

1.03 REFERENCES

A. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2004.

B. AAMA 501.2 - Field Check of Metal Storefronts, Curtain Walls, and Sloped Glazing Systems for Water Leakage; American Architectural Manufacturers Association; 2003 (part of AAMA 501).

C. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.

D. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2004.

E. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2004.

F. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2005a.

G. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2005a.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details.

C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.

D. Design Data: Provide framing member structural and physical characteristics, dimensional limitations.

E. Hardware Schedule: Complete itemization of each item of hardware to be provided for each door, cross-referenced to door identification numbers in Contract Documents.

F. Samples: Submit two samples ____x____ inches (____x____ mm) in size illustrating finished aluminum surface, glass, glazing materials.

G. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.

H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer and Installer: Company specializing in manufacturing aluminum glazing systems with minimum three years of documented experience.

1.06 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Handle products of this section in accordance with AAMA CW-10.

B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings which bond to aluminum when exposed to sunlight or weather.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C). Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Kawneer Company, Inc..
   1. Entrance Framing; Product 451T.

2. Entrance Doors, Medium Style; Product 350.
3. Flush Aluminum Exterior Doors, Exterior Grade; Product Flushline.

B. Other Acceptable Manufacturers:
1. Amarlite Architectural Products.www.amarlite.com
2. YKK AP America, Inc..
3. Substitutions: See Section 01600 - Product Requirements.

2.02 COMPONENTS

A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
1. Unitized, shop assembly.
2. Finish: Solvent-free architectural powder coating certified to meet AAMA 2604-98.
3. Color: As selected on approved shop drawings from manufacturer's full range of colors.

B. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
1. Glazing stops: Flush.
2. Cross-Section: As indicated on drawings.

C. Doors: Glazed aluminum.
1. Thickness: 1-3/4 inches (43 mm).
2. Top Rail: 3-1/2 inches (89 mm) wide.
3. Vertical Stiles: 3-1/2 inches (89 mm) wide.
4. Bottom Rail: 6-1/2 inches (165 mm) wide.
5. Glazing Stops: Square.
6. Finish: Same as storefront.

D. Doors: Flush aluminum.
1. Thickness: 1-3/4 inches (43 mm).
2. Face Sheet: Embossed pattern.
3. Finish: Same as storefront.

2.03 MATERIALS

A. Extruded Aluminum: ASTM B 221 (ASTM B 221M).

B. Sheet Aluminum: ASTM B 209 (ASTM B209M).

C. Fasteners: Stainless steel.

D. Exposed Flashings: 0.032 inch (0.8 mm) thick aluminum sheet; finish to match framing members.

E. Concealed Flashings: 0.018 inch (0.5 mm) thick stainless steel.

F. Perimeter Sealant: Type as specified in Section 07900.

G. Glass: As specified in Section 08800.

H. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.04 FINISHES

A. Comply with AA DAF-45 for aluminum finishes required.

B. High Performance Finish: AAMA 2604-98 solvent-free architectural powder coating; color as selected from manufacturer's standard colors as indicated on approved shop drawings.

C. Touch-Up Materials: As recommended by coating manufacturer for field application.

2.05 HARDWARE

A. Weatherstripping: Thermoplastic elastomer on a tubular shape with a semi-rigid polymeric backing, continuous and replaceable; provide on all doors.

B. Sill Sweep Strips: Resilient seal type, of EPDM blade gasket sweep strip in an aluminum extrusion, surface applied to the interior face with concealed fasteners; provide on all doors.

C. Threshold: Extruded aluminum, one piece per door opening with returned closed ends, ribbed surface; provide on all exterior doors.

D. Pivots: Offset type; top, intermediate, and bottom.
1. Provide on all doors.

E. Pull Handle: _____.
1. Provide on single doors and active door at pairs.

F. Exit Devices: concealed rod type equal to Dor-O-Matic #1490.
1. Provide on all active doors.

G. Closers: _____.
1. Provide on all doors, active and inactive.

H. Glazed Doors' Locks:; keyed cylinder outside.
1. Provide on all active doors.

I. Flush Doors' Locks: Dead latch with thumbturn inside; keyed cylinder outside.
1. Provide on all active doors.

2.06 FABRICATION

A. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices. Fabricate anchors.

D. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.

E. Arrange fasteners and attachments to conceal from view.

F. Reinforce components internally for door hardware.

G. Reinforce framing members for imposed loads.

H. Finishing: Apply factory finish to all surfaces that will be exposed in completed assemblies.
   1. Touch-up surfaces cut during fabrication so that no natural aluminum is visible in completed assemblies, including joint edges.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify dimensions, tolerances, and method of attachment with other work.

B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION

A. Install wall system in accordance with manufacturer's instructions.

B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.

C. Provide alignment attachments and shims to permanently fasten system to building structure.

D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

E. Provide thermal isolation where components penetrate or disrupt building insulation.

F. Coordinate attachment and seal of perimeter air and vapor barrier materials.

G. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

H. Set thresholds in bed of mastic and secure.

I. Install hardware using templates provided.
   1. See Section 08710 for hardware installation requirements.

J. Install glass in accordance with Section 08800, using glazing method required to achieve performance criteria.

3.03 ERECTION TOLERANCES

A. Maximum Variation from Plumb: 0.06 inches every 3 ft (1.5 mm/m) non-cumulative or 1/16 inches per 10 ft (1.5 mm/3 m), whichever is less.

B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch (0.8 mm).

3.04 FIELD QUALITY CONTROL

A. See Section 01400 - Quality Requirements, for independent testing and inspection requirements. Inspection will monitor quality of installation and glazing.

B. Test installed storefront for water leakage in accordance with AAMA 501.2.

3.05 ADJUSTING

A. Adjust operating hardware for smooth operation.

3.06 CLEANING AND PROTECTION

A. Remove protective material from pre-finished aluminum surfaces.

B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.

C. Remove excess sealant by method acceptable to sealant manufacturer.

D. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

E. Protect finished work from damage.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Extruded aluminum windows with fixed sash and operating sash.

B. Factory glazing.

C. Operating hardware.

D. Insect screens.

1.02 RELATED SECTIONS

A. Section 05500 - Metal Fabrications: Steel lintels.

B. Section 07900 - Joint Sealers: Perimeter sealant and back-up materials.

C. Section 08800 - Glazing.

1.03 REFERENCES

A. AAMA/WDMA/CSA 101/I.S.2/A440 - Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors; American Architectural Manufacturers Association; 2005.

B. AAMA CW-10 - Care and Handling of Architectural Aluminum From Shop to Site; American Architectural Manufacturers Association; 2004.

C. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2005a.

D. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric); 2005a.

E. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).

F. SSPC-Paint 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel, Type I and Type II; Society for Protective Coatings; 1997 (Ed. 2004).

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide component dimensions, information on glass and glazing, internal drainage details, and descriptions of hardware and accessories.

C. Shop Drawings: Indicate opening dimensions, elevations of different types, framed opening tolerances, method for achieving air and vapor barrier seal to adjacent construction, anchorage locations,, and installation requirements.

D. Samples: Submit two samples, 12 x 12 inch (300 x 300 mm) in size illustrating typical corner construction, accessories, and finishes.

E. Submit two samples of operating hardware.

F. Certificates: Certify that windows meet or exceed specified requirements.

G. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.

1.05 QUALITY ASSURANCE

A. Comply with requirements of AAMA 101 Designation ____.
   1. Maintain one copy of document on site.

B. Manufacturer and Installer: Company specializing in fabrication of commercial aluminum windows of types required, with not fewer than three years of experience.

1.06 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Comply with requirements of AAMA CW-10.

B. Protect finished surfaces with wrapping paper or strippable coating during installation. Do not use adhesive papers or sprayed coatings that bond to substrate when exposed to sunlight or weather.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not install sealants when ambient temperature is less than 40 degrees F (5 degrees C).

B. Maintain this minimum temperature during and 24 hours after installation of sealants.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.

D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Kawneer Company, Inc.; Product Sealair - Series 8225T-L-F.

B. Other Acceptable Manufacturers:
   1. Amarlite Architectural Products.www.amarlite.com
   2. YKK AP America, Inc..www.ykkap.com
   3. Substitutions: See Section 01600 - Product Requirements.

2.02 WINDOWS

A. Windows - General: Tubular aluminum sections, factory fabricated, factory finished, thermally broken, vision glass, related flashings, anchorage and attachment devices.

B. Fixed, Non-Operable Type:
   1. Construction: Thermally broken.
   2. Glazing: Double; bronze tinted; low-e.
   3. Finish: To match adjacent operable window.

C. Outswinging Casement Type:
   1. Construction: Thermally broken.
   2. Provide screens.
   3. Glazing: Double; bronze tinted; low-e.
   4. Exterior Finish: Solvent-free architectural powder coating certified to meet AAMA 2604-98.
   5. Interior Finish: Solvent-free architectural powder coating certified to meet AAMA 2604-98.

2.03 COMPONENTS

A. Frames: 3-11/16 inch (94 mm) wide x 2-1/4 inch (57 mm) deep profile, of 1/8 inch (3.17 mm) thick section; thermally broken with interior portion of frame insulated from exterior portion; flush glass stops of snap-on type.

B. Sills: 1/8 inch (3.17 mm) thick, extruded aluminum; sloped for positive wash; fit under sash leg and extending such that the end of a 45 degree drip is 1/2 inch (12 mm) beyond wall face; one piece full width of opening jamb angles to terminate sill end.

C. Insect Screen Frame: Rolled aluminum frame of rectangular sections; fit with adjustable hardware; nominal size similar to operable glazed unit.

D. Insect Screens: Woven aluminum mesh; 18/16 mesh size set with extruded vinyl splines, removable to permit rescreening.
   1. Finish: To match operable window.

E. Operable Sash Weatherstripping: Resilient foam core cladded with UV-resistant elastomer; permanently resilient, profiled to achieve effective weather seal.

F. Fasteners: Stainless steel.

G. Glass and Glazing Materials: As specified in Section 08800.

H. Sealant and Backing Materials: As specified in Section 07900.

2.04 MATERIALS

A. Extruded Aluminum: ASTM B 221 (ASTM B 221M), 6063 alloy, T5 temper.

2.05 HARDWARE

A. Sash lock: Lever handle with cam lock.

B. Projecting Sash Arms: Cadmium plated steel, friction pivot joints with nylon bearings, removable pivot clips for cleaning.

C. Pulls: Manufacturer's standard type.

D. Bottom Rollers: Stainless steel, adjustable.

E. Limit Stops: Resilient rubber.

2.06 FABRICATION

A. Fabricate components with smallest possible clearances and shim spacing around perimeter of assembly that will enable window installation and dynamic movement of perimeter seal.

B. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

C. Prepare components to receive anchor devices.

D. Arrange fasteners and attachments to ensure concealment from view.

E. Prepare components with internal reinforcement for operating hardware.

F. Provide steel internal reinforcement in mullions as required to meet loading requirements.

G. Provide internal drainage of glazing spaces to exterior through weep holes.

H. Assemble insect screen frames with mitered and reinforced corners. Secure wire mesh tautly in frame. Fit frame with four, spring loaded steel pin retainers.

I. Double weatherstrip operable units.

J. Factory glaze window units.

2.07 FINISHES

A. Powder Coating: Solvent-free architectural powder coating certified to meet AAMA 2604-98

B. Operator and Exposed Hardware: Enameled to _____ color.

C. Apply 1 coat of bituminous coating to concealed aluminum and steel surfaces in contact with dissimilar materials.

D. Shop and Touch-Up Primer for Steel Components: SSPC-Paint 25, zinc oxide, alkyd, linseed oil primer.

E. Touch-Up Primer for Galvanized Steel Surfaces: SSPC-Paint 20, zinc rich.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that wall openings and adjoining air and vapor seal materials are ready to receive aluminum windows.

3.02 INSTALLATION

A. Install windows in accordance with manufacturer's instructions.

B. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.

C. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent work.

D. Install sill and sill end angles.

E. Provide thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

F. Coordinate attachment and seal of perimeter air barrier and vapor retarder materials.

G. Install operating hardware not pre-installed by manufacturer.

H. Install glass and infill panels in accordance with requirements specified in Section 08800.

I. Install perimeter sealant in accordance with requirements specified in Section 07900.

3.03 ERECTION TOLERANCES

A. Maximum Variation from Level or Plumb: 1/16 inches every 3 ft (1.5 mm/m) non-cumulative or 1/8 inches per 10 ft (3 mm/3 m), whichever is less.

3.04 ADJUSTING AND CLEANING

A. Adjust hardware for smooth operation and secure weathertight closure.

B. Remove protective material from factory finished aluminum surfaces.

C. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.

D. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

END OF SECTION

SECTION 08800

GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Glass.

B. Glazing compounds and accessories.

1.02 RELATED SECTIONS

A. Section 07260 - Vapor Retarders.

B. Section 07900 - Joint Sealers: Sealant and back-up material.

C. Section 08110 - Steel Doors and Frames: Glazed borrowed lites.

D. Section 08410 - Metal-Framed Storefronts.

E. Section 08520 - Aluminum Windows: Glazed windows.

F. Section 10800 - Toilet, Bath, and Laundry Accessories: Mirrors.

1.03 REFERENCES

A. ASTM C 864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers; 2005.

B. ASTM C 920 - Standard Specification for Elastomeric Joint Sealants; 2005.

C. ASTM C 1036 - Standard Specification for Flat Glass; 2001.

D. ASTM C 1048 - Standard Specification for Heat-Treated Flat Glass--Kind HS, Kind FT Coated and Uncoated Glass; 2004.

E. ASTM C 1193 - Standard Guide for Use of Joint Sealants; 2005a.

F. ASTM E 2190 - Standard Specification for Insulating Glass Unit Performance and Evaluation; 2002.

G. GANA (GM) - GANA Glazing Manual; Glass Association of North America; 2004.

H. GANA (SM) - FGMA Sealant Manual; Glass Association of North America; 1990.

1.04 PERFORMANCE REQUIREMENTS

A. Provide glass and glazing materials for continuity of building enclosure vapor retarder and air barrier:
   1. In conjunction with vapor retarder and joint sealer materials described in other sections.
   2. To utilize the inner pane of multiple pane sealed units for the continuity of the air barrier and vapor retarder seal.
   3. To maintain a continuous air barrier and vapor retarder throughout the glazed assembly from glass pane to heel bead of glazing sealant.

1.05 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.

C. Product Data on Glazing Compounds: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors.

D. Samples: Submit two samples 12 x 12 inch (305 x 305 mm) in size of glass units, showing coloration.

E. Certificates: Certify that products meet or exceed specified requirements.

F. Manufacturer's Certificate: Certify that glass meets or exceeds specified requirements.

1.06 QUALITY ASSURANCE

A. Perform Work in accordance with GANA Glazing Manual and FGMA Sealant Manual for glazing installation methods.

B. Installer Qualifications: Company specializing in performing the work of this section with minimum ten years documented experience.

1.07 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.08 ENVIRONMENTAL REQUIREMENTS

A. Do not install glazing when ambient temperature is less than 50 degrees F (10 degrees C).

B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY

A. See Section 01780 - Closeout Submittals, for additional warranty requirements.

B. Provide a five (5) year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.

PART 2 PRODUCTS

2.01 FLAT GLASS MATERIALS

A. Manufacturers:
   1. ACH Glass/Versalux: www.versaluxglass.com.
   2. AFG Industries, Inc: www.afgglass.com.
   3. Pilkington Building Products North America: www.pilkington.com.
   4. PPG Industries, Inc: www.ppg.com.
   5. Substitutions: Refer to Section 01600 - Product Requirements.

B. Clear Float Glass (Type A): Clear, fully tempered with horizontal tempering.
   1. Comply with ASTM C 1036, Type I, transparent flat, Class 1 clear, Quality Q3 (glazing select).
   2. Comply with ASTM C 1048.
   3. 6 mm minimum thick.

C. Tinted Glass (Type B): Float type, tempered, bronze color.
   1. Light transmittance of 20 percent, shading coefficient of 0.37.
   2. Comply with ASTM C 1036, Type I, transparent flat, Class 2, Quality Q3 (glazing select).
   3. Comply with ASTM C 1048.
   4. 6 mm minimum thick.

D. Low E Glass (Type C): Float type, heat strengthened, clear.
   1. Coating on inner (#3) surface.
   2. Comply with ASTM C 1036, Type I, transparent flat, Quality Q3 (glazing select).
   3. Comply with ASTM C 1048.
   4. 6 mm minimum thick.

E. Wired Glass (Type D): Clear.
   1. Stainless steel wire in square mesh pattern.
   2. 1/2 inch (12 mm) grid size.
   3. Comply with ASTM C 1036.
   4. 1/4 inch (6 mm) thick.

2.02 SEALED INSULATING GLASS MATERIALS

A. Manufacturers:
   1. Any of the manufacturers listed under Flat Glass Materials.
   2. Cardinal Glass Industries: www.cardinalcorp.com.
   3. Guardian Industries Corporation: www.guardian.com.
   4. Viracon, Apogee Enterprises, Inc: www.viracon.com.
   5. Substitutions: Refer to Section 01600 - Product Requirements.

B. Insulated Glass Units (Type E): Double pane with glass to elastomer edge seal.
   1. Outer pane of tinted (Type B) glass, inner pane of clear float (Type A) glass.
   2. Place low E coating on No. 3 surface within the unit.
   3. Durability: Certified by an independent testing agency to comply with ASTM E 2190.
   4. Purge interpane space with dry hermetic air.
   5. Total unit thickness of 1 inch (25 mm) minimum.

C. Edge Seal Construction: Aluminum, bent and soldered corners.

D. Edge Seal Material: Black color.

2.03 GLAZING COMPOUNDS

A. Manufacturers:
   1. Bostik, Inc: www.bostik-us.com.

2. GE Silicones: www.gesilicones.com.
3. Pecora Corporation: www.pecora.com.
4. BASF Construction Chemicals, Inc: www.chemrex.com.
5. Substitutions: Refer to Section 01600 - Product Requirements.

B. Silicone Sealant (Type 1): Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C 920, Type S, Grade NS, Class 25, Uses M, A, and G; cured Shore A hardness of 15 to 25; color as selected in approved shop drawings.

2.04 GLAZING ACCESSORIES

A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness, ASTM C 864 Option I. Length of 0.1 inch for each square foot (25 mm for each square meter) of glazing or minimum 4 inch (100 mm) x width of glazing rabbet space minus 1/16 inch (1.5 mm) x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch (75 mm) long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.

C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10 to 15 Shore A durometer hardness; coiled on release paper; ____x____ inch (____x____ mm) size; black color.
1. Manufacturers:
   a. Pecora Corporation: www.pecora.com.
   b. Tremco, Inc: www.tremcosealants.com.
   c. Substitutions: Refer to Section 01600 - Product Requirements.

D. Glazing Gaskets: Resilient EPDM extruded shape to suit glazing channel retaining slot; ASTM C 864 Option I; color selected on approved shop drawing.

E. Glazing Clips: Manufacturer's standard type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that openings for glazing are correctly sized and within tolerance.

B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

D. Install sealants in accordance with ASTM C 1193 and FGMA Sealant Manual.

E. Install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION - EXTERIOR/INTERIOR DRY METHOD (GASKET GLAZING)

A. Place setting blocks at 1/4 points with edge block no more than 6 inches (150 mm) from corners.

B. Rest glazing on setting blocks and push against fixed stop with sufficient pressure on gasket to attain full contact.

C. Install removable stops without displacing glazing gasket; exert pressure for full continuous contact.

3.04 INSTALLATION - INTERIOR WET METHOD (COMPOUND AND COMPOUND)

A. Install glazing resting on setting blocks. Install applied stop and center pane by use of spacer shims at 24 inch (600 mm) centers, kept 1/4 inch (6 mm) below sight line.

B. Locate and secure glazing pane using glazers' clips.

C. Fill gaps between glazing and stops with glazing compound until flush with sight line. Tool surface to straight line.

3.05 MANUFACTURER'S FIELD SERVICES

A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.

B. Monitor and report installation procedures and unacceptable conditions.

3.06 CLEANING

A. Remove glazing materials from finish surfaces.

B. Remove labels after Work is complete.

C. Clean glass and adjacent surfaces.

3.07 PROTECTION OF FINISHED WORK

A. After installation, mark pane with an 'X' by using removable plastic tape or paste.

3.08 SCHEDULE

A. Aluminum Windows: Type E, exterior/interior dry method (Gasket Glazing).

B. Metal-Framed Storefronts and Doors: Type [E], thicknesses required to comply with performance requirements, exterior dry method.

C. Hollow Steel Frames - Interior: Interior wet method with Type [1] compound.

D. Steel Doors:

1. Fire-rated: Wired glass, Type [B], 6 mm thick, interior wet method with Type [1] compound.

END OF SECTION

SECTION 09300

TILE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Tile for floor applications.

B. Tile for wall applications.

C. Stone thresholds.

D. Ceramic trim.

1.02 RELATED SECTIONS

A. Section 07130 - Sheet Waterproofing.

B. Section 15410 - Plumbing Fixtures: Premanufactured Shower.

1.03 REFERENCES

A. ANSI A108 Series/A118 Series/A136.1 - American National Standard Specifications for the Installation of Ceramic Tile (Compendium); 2005.
   1. ANSI A108.1a - American National Standard Specifications for Installation of Ceramic Tile in the Wet-Set Method, with Portland Cement Mortar; 2005.
   2. ANSI A108.1b - American National Standard Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2005).
   3. ANSI A108.1c - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar or Installation of Ceramic Tile on a Cured Portland Cement Mortar Bed with Dry-Set or Latex Portland Cement Mortar; 1999 (R2005).
   4. ANSI A108.4 - American National Standard Specifications for Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesive; 1999 (R2005).
   5. ANSI A108.5 - American National Standard Specifications for Installation of Ceramic Tile with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar; 1999 (R2005).
   6. ANSI A108.6 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant, Water Cleanable Tile-Setting and -Grouting Epoxy; 1999 (R2005).
   7. ANSI A108.8 - American National Standard Specifications for Installation of Ceramic Tile with Chemical Resistant Furan Resin Mortar and Grout; 1999 (R2005).
   8. ANSI A108.9 - American National Standard Specifications for Installation of Ceramic Tile with Modified Epoxy Emulsion Mortar/Grout; 1999 (R2005).
   9. ANSI A108.10 - American National Standard Specifications for Installation of Grout in Tilework; 1999 (R2005).

10. ANSI A118.7 - American National Standard Specifications for Polymer Modified Cement Grouts for Tile Installation; 1999 (R2005).
11. ANSI A118.10 - American National Standard Specifications for Load Bearing, Bonded, Waterproof Membranes for Thin-Set Ceramic Tile and Dimension Stone Installation; 1999 (R2005).
12. ANSI A136.1 - American National Standard for Organic Adhesives for Installation of Ceramic Tile; 1999 (R2005).
13. ANSI A137.1 - American National Standard Specifications for Ceramic Tile; 1988.

B. TCA (HB) - Handbook for Ceramic Tile Installation; Tile Council of North America, Inc.; 2006.

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.

C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.

D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches (450 x 450 mm) in size illustrating pattern, color variations, and grout joint size variations.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

1.05 QUALITY ASSURANCE

A. Maintain one copy of TCA Handbook and ANSI A108 Series/A118 Series on site.

B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum 5 years of documented experience.

C. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.

1.06 MOCK-UP

A. See Section 01400 - Quality Requirements, for general requirements for mock-up.

B. Construct tile mock-up as directed by the Architect, incorporating all components specified for the location.
1. Minimum size of mock-up: 4 feet x 4 feet.
2. Approved mock-up may remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Protect adhesives from freezing or overheating in accordance with manufacturer's instructions.

1.09 ENVIRONMENTAL REQUIREMENTS

A. Do not install adhesives in an unventilated environment.

B. Maintain ambient and substrate temperature of 50 degrees F (10 degrees C) during installation of mortar materials.

1.10 EXTRA MATERIALS

A. Provide 10 sq. ft (1 sq. m) of each size, color, and surface finish of tile specified.

PART 2 PRODUCTS

2.01 TILE

A. Manufacturers: All products by the same manufacturer.
   1. American Olean: www.americanolean.com.
   2. Dal-Tile Corporation: www.daltile.com.
   3. Summitville Tiles, Inc: www.summitville.com.
   4. Substitutions: See Section 01600 - Product Requirements.

B. Ceramic Mosaic Tile: ANSI A137.1, and as follows:
   1. Moisture Absorption: 0 to 0.5 percent.
   2. Size and Shape: 1 inch square (25 mm square).
   3. Edges: Square.
   4. Surface Finish: Unglazed.
   5. Colors: To be selected from manufacturer's standard range.
   6. Mounted Sheet Size: 12 x 12 inches (305 x 305 mm).
   7. Trim Units: Matching bead, cove, and surface bullnose shapes in sizes coordinated with field tile.

C. Glazed Wall Tile: ANSI A137.1, and as follows:
   1. Moisture Absorption: 3.0 to 7.0 percent.
   2. Size and Shape: 4-1/4 inch (108 mm) square.
   3. Edges: Cushioned.
   4. Surface Finish: High gloss.
   5. Colors: To be selected from manufacturer's standard range.
   6. Trim Units: Matching bullnose, cove, and base shapes in sizes coordinated with field tile.

2.02 TRIM AND ACCESSORIES

A. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
   1. Applications: Use in the following locations:
      a. Open Edges: Bullnose.
      b. Inside Corners: Jointed.

c. Floor to Wall Joints: Cove base.

2. Manufacturer: Same as for tile.

B. Thresholds: Marble, white, honed finish; 2 inches (50 mm) wide by full width of wall or frame opening; 1/2 inch (12 mm) thick thick; beveled one long edge with radiused corners on top side; without holes, cracks, or open seams.

1. Applications: Provide at the following locations:
   a. At doorways where tile terminates.

2.03 ADHESIVE MATERIALS

A. Manufacturers:

1. W.R. Bonsal Co; Product ____: www.bonsal.com.
2. Bostik, Inc; Product ____: www.bostik-us.com.
3. Mapei Corporation; Product ____: www.mapei.com.
4. Substitutions: See Section 01600 - Product Requirements.

B. Organic Adhesive: ANSI A136.1, thinset bond type; use Type I in areas subject to prolonged moisture exposure.

2.04 MORTAR MATERIALS

A. Manufacturers:

1. W.R. Bonsal Co; Product ____: www.bonsal.com.
2. Bostik, Inc; Product ____: www.bostik-us.com.
3. Custom Building Products; Product ____: www.custombuildingproducts.com.
4. Substitutions: See Section 01600 - Product Requirements.

B. Mortar Bed Materials: Portland cement, sand, latex additive, _____ and water.

2.05 GROUT MATERIALS

A. Manufacturers:

1. W.R. Bonsal Co; Product ____: www.bonsal.com.
2. Bostik, Inc; Product ____: www.bostik-us.com.
3. Custom Building Products; Product ____: www.custombuildingproducts.com.
4. Substitutions: See Section 01600 - Product Requirements.

B. Standard Grout: Polymer modified cement grout, sanded or unsanded, as specified in ANSI A118.7.

1. Color: As selected from manufacturer's full range of colors on approved shop drawing.

2.06 ACCESSORY MATERIALS

A. Waterproofing Membrane at Floors: PVC sheet membrane, 40 mils (1 mm) thick, minimum; specifically designed for bonding to cementitious substrate under thick mortar bed or thin-set tile; complying with ANSI A118.10.

1. Manufacturers:
   a. Compotite Corporation; Composeal Gold: www.compotite.com.
   b. Substitutions: See Section 01600 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.

B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.

C. Verify that sub-floor surfaces are dust-free and free of substances which would impair bonding of setting materials to sub-floor surfaces.

D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.

E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION

A. Protect surrounding work from damage.

B. Vacuum clean surfaces and damp clean.

C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

D. Prepare substrate surfaces for adhesive installation in accordance with adhesive manufacturer's instructions.

3.03 INSTALLATION - GENERAL

A. Install tile and thresholds and grout in accordance with applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and TCA Handbook recommendations.

B. Request tile pattern. Do not interrupt tile pattern through openings.

C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor, base, and wall joints.

D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.

E. Form internal angles square and external angles bullnosed.

F. Install thresholds where indicated.

G. Sound tile after setting. Replace hollow sounding units.

H. Allow tile to set for a minimum of 48 hours prior to grouting.

I. Grout tile joints. Use standard grout unless otherwise indicated.

J. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS

A. Over interior concrete substrates, install in accordance with TCA Handbook Method F116, organic adhesive, with standard grout, unless otherwise indicated.
   1. Where waterproofing membrane is indicated, install in accordance with TCA Handbook Method F122, with latex-portland cement grout.

3.05 INSTALLATION - WALL TILE

A. Over interior concrete and masonry install in accordance with TCA Handbook Method W202, thin-set with dry-set or latex-portland cement bond coat.

3.06 CLEANING

A. Clean tile and grout surfaces.

3.07 PROTECTION OF FINISHED WORK

A. Do not permit traffic over finished floor surface for 4 days after installation.

END OF SECTION

SECTION 09511

SUSPENDED ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Suspended metal grid ceiling system.

B. Acoustical units.

1.02 RELATED SECTIONS

A. Section 07212 - Board and Batt Insulation: Acoustical insulation.

B. Section 07900 - Joint Sealers: Acoustical sealant.

1.03 REFERENCES

A. ASTM C 635 - Standard Specification for the Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-in Panel Ceilings; 2004.

B. ASTM C 636 - Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels; 2004.

C. ASTM E 580 - Standard Practice for Application of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Requiring Seismic Restraint; 2002.

D. ASTM E 1264 - Standard Classification for Acoustical Ceiling Products; 1998 (Reapproved 2005).

1.04 SUBMITTALS

A. See Section 01300 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate grid layout and related dimensioning.

C. Product Data: Provide data on suspension system components.

D. Samples: Submit two samples 6 x 6 inch (151 x 151 mm) in size illustrating material and finish of acoustical units.

E. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE

A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.06 ENVIRONMENTAL REQUIREMENTS

A. Maintain uniform temperature of minimum 60 degrees F (16 degrees C), and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.

1.07 PROJECT CONDITIONS

A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.

B. Install acoustical units after interior wet work is dry.

1.08 EXTRA MATERIALS

A. See Section 01600 - Product Requirements, for additional provisions.

B. Provide 10 percent of total acoustical unit area of each type of acoustical unit for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 ACOUSTICAL UNITS

A. Manufacturers:
1. Armstrong World Industries, Inc; Product ____: www.armstrong.com.
2. BPB America Inc; Product ____: www.bpb-na.com.
3. USG; Product ____: www.usg.com.
4. Substitutions: See Section 01600 - Product Requirements.

B. Acoustical Units - General: ASTM E 1264, Class A.

C. Acoustical Panels Type A: Painted mineral fiber, ASTM E 1264 Type III, with the following characteristics:
1. Size: 24 x 48 inches (600 x 1200 mm).
2. Thickness: 3/4 inches (19 mm).
3. Composition: Wet felted.
4. Density: ____ lb/cu ft (____ kg/cu cm).
5. Light Reflectance: 0.83 percent, determined as specified in ASTM E 1264.
6. NRC Range: ____ to ____, determined as specified in ASTM E 1264.
7. Articulation Class (AC): 170, determined as specified in ASTM E 1264.
8. Edge: Square.
9. Surface Color: White.
10. Surface Pattern: Non-directional fissured.
11. Suspension System: Exposed grid Type ____.

D. Acoustical Panels Type B: Plastic faced mineral fiber, ASTM E 1264 Type IV, with the following characteristics:
1. Size: 24 x 24 inches (600 x 600 mm).
2. Thickness: 5/8 inches (15 mm).
3. Composition: Wet felted.
4. Density: ____ lb/cu ft (____ kg/cu cm).
5. Light Reflectance: 0.80 percent, determined as specified in ASTM E 1264.

6. NRC Range: 50 to 60, determined as specified in ASTM E 1264.
7. Edge: Square.
8. Surface Color: White.
9. Surface Pattern: Perforated, small holes.
10. Suspension System: Exposed grid Type ____.

2.02 SUSPENSION SYSTEM(S)

A. Manufacturers:
1. Same as for acoustical units.
2. Chicago Metallic Corporation; Product ____: www.chicagometallic.com.
3. Substitutions: See Section 01600 - Product Requirements.

B. Suspension Systems - General: ASTM C 635; die cut and interlocking components, with stabilizer bars, clips, splices, and perimeter moldings as required.

C. Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; intermediate-duty.
1. Profile: Tee; 15/16 inch (24 mm) wide face.
2. Construction: Double web.
3. Finish: White painted.

2.03 ACCESSORIES

A. Support Channels and Hangers: Galvanized steel; size and type to suit application, seismic requirements, and ceiling system flatness requirement specified.

B. Perimeter Moldings: Same material and finish as grid.
1. At Exposed Grid: Provide L-shaped molding for mounting at same elevation as face of grid.

C. Acoustical Sealant For Perimeter Moldings: Specified in Section 07900.

D. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.

E. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that layout of hangers will not interfere with other work.

3.02 INSTALLATION - SUSPENSION SYSTEM

A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer's instructions and as supplemented in this section.

B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:360.

C. Locate system on room axis according to reflected plan.

D. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.

E. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.

F. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.

G. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.

H. Support fixture loads using supplementary hangers located within 6 inches (150 mm) of each corner, or support components independently.

I. Do not eccentrically load system or induce rotation of runners.

J. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Install with continuous gasket.
   2. Use longest practical lengths.
   3. Overlap and rivet corners.

3.03 INSTALLATION - ACOUSTICAL UNITS

A. Install acoustical units in accordance with manufacturer's instructions.

B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.

C. Lay directional patterned units with pattern parallel to longest room axis.

D. Fit border trim neatly against abutting surfaces.

E. Install units after above-ceiling work is complete.

F. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.

G. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Double cut and field paint exposed reveal edges.

H. Where round obstructions occur, provide preformed closures to match perimeter molding.

I. Install hold-down clips on panels within 20 ft (6 m) of an exterior door.

3.04 ERECTION TOLERANCES

A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet (3 mm in 3 m).

B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

3.05 SCHEDULE

A. Type B: Lockers, including Storage Rooms, Janitor and Lavatory: 24 x 24 inch (600 x 600 mm) mineral acoustical units, plastic faced, interlocking exposed T suspension grid, insulation batts placed over units.

B. Type A: All other areas. 24 x 48 inch (600 x 1 200 mm) square edge mineral acoustical units, interlocking exposed T suspension grid.

END OF SECTION

SECTION 09900

PAINTS AND COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Surface preparation, interior and exterior painting, and repaint work.
   2. Paint Schedule.
   3. Piping markers and safety signs.

1.02 REFERENCES

A. American National Standards Institute:
   1. ANSI/NSF Standard 61 Listing of Certified Drinking Water System Components - Health Effects.
   2. ANSI Z53.1, Safety Color Code for Marking Physical Hazards.

B. Occupational Safety and Health Act (OSHA):
   1. OSHA 1910.144, Safety Color Code for Marking Physical Hazards.
   2. OSHA 1910.145, Specifications for accident prevention signs and tags.

C. Steel Structures Painting Council:
   1. Surface Preparation Specifications:
      a. SSPC-SP 1, Solvent Cleaning.
      b. SSPC-SP 2, Hand Tool Cleaning.
      c. SSPC-SP 3, Power Tool Cleaning.
      d. SSPC-SP 6, Commercial Blast Cleaning.
      e. SSPC-SP 8, Pickling.
      f. SSPC-SP 10, Near-White Blast Cleaning.

1.03 DEFINITIONS

A. The term "paint" as used in this Section means coating system materials, including pretreatments, primers, emulsions, enamels, stain, sealers, fillers, and other applied materials whether used as prime, intermediate or finish coats.

B. The term "exposed" as used in this Section means all items not covered with concrete, masonry, or similar material.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Ensure surfaces are properly prepared, proper primer applied to correct mil thickness, and finish coat is compatible with primer coat and applied to correct mil thickness. This requirement applies to all equipment and material, whether

the total process is done in the shop, in the field, or partially in shop and partially in field.

2. Provide paint products supplied by one manufacturer unless otherwise approved by Engineer.

1.05 SUBMITTALS

A. Product Data:
   1. Submit material manufacturer's technical information, including paint label analysis and application instructions for each material proposed.
      a. List each material and cross-reference to specific paint and finish system and application. Identify by manufacturer's catalog number and general classification.
      b. Submit copies of manufacturer's complete color charts for each coating system.
      c. Provide certifications from manufacturers verifying that factory applied prime coats are compatible with specified finish coatings.
      d. Pipe Markers and Safety Signs: Submit copies of manufacturer's technical brochure, including color chart and list of standard signs. Owner will set titles on pipe markers and safety signs.

B. Quality Assurance/Control Submittals:
   1. Applicator Qualifications: Submit qualifications as specified under Quality Assurance Article below.

C. Closeout Submittals:
   1. Submit certificate stating Work was properly prepared and painted in accordance with Specifications.
   2. Submit manufacturer's certificate stating quantity of paint furnished was sufficient to properly coat all surfaces.
   3. Maintenance Manual: Upon completion of work, furnish copies of a detailed maintenance manual including following information:
      a. Product name and number.
      b. Name, address and telephone number of manufacturer and local distributor.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for light repairs such as dents, scratches and staining.

1.06 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Successfully painted utility or industrial installations for at least five years. Submit name and experience record of painting applicator to Engineer. Include a list of at least five utility or industrial installations painted within last five years, along with responsible officials, architects or engineers concerned with project, and the approximate contract price.

2. Painting applicators whose submissions indicate a lack of experience required to perform the work, or have performed work in an unsatisfactory manner, will not be approved.

B. Pre-Installation Meeting: Prior to any painting, arrange a meeting between a representative of the paint manufacturer, the Engineer, and the Contractor's personnel involved in painting. Purpose of meeting is to have paint manufacturer's representative address the following:
   1. Define surface preparation requirements for the different items which are to receive paint.
   2. Review which paint is used on which items and summarize application procedures.
   3. Answer questions.

C. Field Samples:
   1. One (1) room or area will be selected by Engineer to represent typical job surfaces and conditions. Blast clean, clean, paint and finish this room or area in accordance with the schedule and as specified. After finishes are accepted, this room or area will be used for comparison in evaluation of other blast cleaning, painting and finishing of a similar nature.

1.07 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials:
   1. Deliver materials to job site in original, new, and unopened packages and containers bearing manufacturer's name and label with following information:
      a. Name or title of material.
      b. Manufacturer's stock number and date of manufacture.
      c. Manufacturer's name.
      d. Contents by volume, for major pigment and vehicle constituents.
      e. Thinning instructions where recommended.
      f. Application instructions.
      g. Color name and number.

B. Storage of Materials:
   1. Store only acceptable project materials on project site.
   2. Store in a suitable location approved by Engineer. Keep area clean and accessible.
   3. Restrict storage to paint materials and related equipment.
   4. Comply with health and fire regulations including the Occupational Safety and Health Act of 1970.
   5. Keep temperature of storage area above 50 degrees F or manufacturer's recommended storage temperature, whichever is higher.

1.08 PROJECT CONDITIONS

A. Environmental Requirements:
   1. Adhere to manufacturer's data on air and surface temperature limits and relative humidity during application and curing of coatings.
   2. Do not spray apply paint when wind velocity is above 15 mph.
   3. Schedule coating work to avoid dust and airborne contaminants.
   4. Apply exterior finishes during daylight hours only.
   5. When painting in confined spaces, or because of unfavorable ambient conditions, longer drying times will be necessary.
   6. Provide supplementary ventilation such as fans and blowers in confined or enclosed areas to carry off solvents during evaporation stage.

B. Existing Conditions:
   1. Broom clean area before painting is started. Remove dirt and dust.
      a. After painting operations begin, broom cleaning will not be allowed. Clean only with commercial vacuum cleaning equipment.

1.09 PAINT SCHEDULE

A. Paint all exposed surfaces, except where natural finish of material is specifically noted as a surface not to be painted. See Paint Schedule at end of this section for painting requirements.

B. Where items or surfaces are not specifically mentioned, paint these the same as adjacent similar materials or areas.

C. Do not paint the following:
   1. Stainless steel, chromium plate, anodized aluminum and similar finished materials.
   2. Aluminum, except where in contact with dissimilar materials.
   3. Fiberglass items such as tanks, and troughs.
   4. Prefinished Items.
      a. Unless otherwise shown or specified, factory finishing such as baked-on factory porcelain, polyvinylfluoride or other similar finish is specified for such items as, but not limited to, mechanical and electrical equipment such as instruments, light fixtures and distribution cabinets. Touch up factory finished items with paint supplied by the item manufacturer. As directed by Engineer, field paint damaged prefinished items or return them to the factory for repair and repainting.
      b. Any prefinished item not having generic type of paint or proper mil thickness to withstand corrosive atmosphere of water treatment plants shall be returned to the factory for painting or shall have additional coats applied in the field.
   5. Concealed Surfaces:
      a. Unless otherwise shown or specified, nonmetallic wall or ceiling surfaces in concealed from view areas and generally inaccessible areas, such as pipe

spaces, duct shafts, and above acoustical and plaster ceilings, as applicable to this Project.

b. Ducts, conduits and other materials with corrosion-resistant surfaces, not a paint, which are above finished ceilings, shall not require field painting.
c. Structural and miscellaneous metals covered or concealed with an acoustical ceiling, plaster ceiling, fireproof insulation, concrete, masonry, or similar material shall only receive a primer, shop or field, compatible with the covering material before they are covered.
d. Pipe and conduits in concealed from view areas, unless they are non-galvanized ferrous metal. Non-galvanized ferrous pipe and conduit shall be painted in accordance with Painting Schedule. All concealed from view pipe and conduits shall be labeled for identification.

D. Operating Parts and Labels
1. Moving parts of operating units, mechanical and electrical parts, such as valve and damper operators, linkages, sensing devices, motor and fan shafts do not require finish painting unless otherwise specified.
2. Do not paint over any code-required labels, such as UL and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
3. Remove all paint, coating or splatter inadvertently placed on these surfaces.

1.10 COORDINATION

A. Review installation procedures under other Sections and coordinate the installation of items that must be field painted in this Section.

B. Provide finish coats which are compatible with the prime paints used. Review other Sections of these Specifications in which prime paints are to be provided to ensure compatibility of the total coatings system for the various substrates. Contractor responsible for the compatibility of all shop primed and field painted items in this Contract. Furnish information on the characteristics of the finish materials proposed to use, to ensure that compatible prime coats are used. As directed by the Engineer, provide barrier coats over incompatible primers or remove and reprime. Notify the Engineer in writing of anticipated problems using the coating systems as specified with substrates primed by others.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Tnemec Co., Inc.

B. Sherwin Williams.

C. Carboline.

D. MAB Paints, M. A. Bruder & Sons Inc.

2.02 GENERAL

A. Provide the best grade of the various types of coatings suitable for use in water treatment plants as regularly manufactured by acceptable paint materials manufacturers. Materials not displaying the manufacturer's identification as a standard, best-grade product will not be acceptable.

B. Provide primers produced by the same manufacturer as the finish coats. Use only thinners recommended by the paint manufacturer, and use only to recommended limits.

C. Provide paints, pipe marker and safety signs of durable and washable quality. Use materials which will withstand normal washing as required to remove grease, oil, chemicals, etc. without showing discoloration, loss of gloss, staining, or other damage.

2.03 SUBSTITUTIONS

A. No substitutions will be considered that decrease film thickness, number of coats, surface preparation or generic type of coating specified. Furnish same color selection of substituted manufacturers as manufacturers specified, including accent colors in coating systems.

2.04 COLORS AND FINISHES

A. Provide surface treatments and finishes as specified in Painting Schedule at end of this Section.

B. Color Schedule: Colors for painted surfaces will be selected by Owner after Contract is awarded.

C. Piping and Sign Color Code: Colors for piping and signs will be selected by the Owner after Contract is awarded.

D. Use representative colors when preparing samples for Engineer's review. Final acceptance of colors will be from samples applied on the job.

E. Color Pigments: Pure, nonfading, applicable types to suit substrates and service indicated.
   1. Lead: Do not exceed lead content amount permitted by federal, state and local government laws and regulations at time of paint application.
   2. Paints specified for application on submerged metal in contact with potable water shall be approved by the governing health and safety codes.

2.05 PIPING MARKERS AND SAFETY SIGNS

A. Manufacturer: Provide products produced by one of the following:
   1. Seton Name Plate Corporation
   2. W. H. Brady Company

B. Piping Markers
   1. All visible pipelines and conduits shall be color coded. The exceptions are that flexible connectors, flexible tubing, stainless steel, uninsulated copper tubing, and valve operators and appurtenances shall not be painted.
   2. Labels on pipelines are required, and should be the plastic wrap around type, or self sticking type, which are commercially available or spray stenciled labels in the appropriate color. Arrows indicating the direction of flow should be the same color as the lettering.
   3. Valves shall be painted the same color as the pipeline. Exceptions are that brass, bronze, copper, stainless steel, PVC, valve operators, and any flexible portions of these pumps or valves shall not be painted.
   4. Label or stencil lettered legends on the piping at the horizontal or vertical center lines. Place letterings below the horizontal center line where pipelines are too close together or where located above normal line of vision (or above the centerline when pipeline is below the normal line of vision).
   5. Locate lettered legends and bands at the following locations:
      a. Where pipes enter or leave the room space.
      b. At junction points and points of distribution.
      c. Adjacent to valves and equipment.
      d. At changes in direction.
      e. At 30-feet maximum intervals along the piping where necessary for identification.
   6. Stencil same size arrows as letters, indicating direction of flow pointing away from the legend. Letter sizes and band widths are given in the schedule below:

Outside Diameter of Pipe Covering	Height of Letters	Width of Color Band
3/4 to 1-1/4 inch	1/2 inch	4 inch
1-1/2 to 2-1/2 inch	3/4 inch	6 inch
3 to 6 inch	1-1/4 inch	8 inch
7 to 10 inch	2-1/2 inch	12 inch
Over 10 inch	3-1/2 inch	12 inch

   7. Cleanup and retouch as necessary all affected work. Leave all glass areas, unpainted fittings, plaster surfaces, floors and walks, hardware, and other surfaces clean and free from any paint, stain, smears, spatterings or smudges.
   8. Do not paint over equipment identification tags.

C. Safety Signs: Provide safety signs meeting OSHA and ANSI Z53.1 Specifications. Attach with 4 stainless steel screws or similar fasteners suitable for substrate. Comply with following requirements:

1. Provide 10 inch by 14 inch, 0.125 inch thick polyethylene urethane coated chemical sign with NFPA labeling for each process chemical. Location of each sign established in field by Engineer.
2. Provide fifty 12 inch by 10 inch, 0.55 inch thick polyethylene personal protection, informational and directional signs. Signs coated with clear liquid plastic containing ultraviolet inhibitors to provide protection from fading. Wordage of each sign selected by Engineer from manufacturer's standard legends during shop drawing review.
3. Manufacturer: Direct Safety Company, Phoenix, Arizona.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions where painting work is to be performed. Notify Engineer in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

B. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

C. Remove by blast cleaning to SSPC-SP 10 any bitumastic coating or improper primer on any material or equipment which is to be painted and arrives at the construction site with a bitumastic coating or a priming system not specified in the Painting Schedule.

3.02 SURFACE PREPARATION

A. General:
   1. Perform all preparation and cleaning procedures as specified and in strict accordance with paint manufacturer's instructions for each particular substrate and atmospheric condition.
   2. Remove hardware, hardware accessories, machined surfaces, plates, lighting fixtures, and similar items not to be finish painted, or provide surface applied protection prior to surface preparation and painting operations. Following completion of painting of each space or area, reinstall removed items by workmen skilled in the trades involved or remove applied protection, if applicable.
   3. Clean sand, dirt, dust and all other foreign matter from surfaces to be painted before applying paint or surface treatments. Remove oil and grease with clean cloths and cleaning solvents prior to mechanical cleaning. Program cleaning and painting so that dust and other contaminants from cleaning process will not fall in wet, newly painted surfaces.
   4. Prepare surfaces which were not shop painted or were improperly shop painted or damaged, and all abraded or rusted surfaces, which are to be painted, as specified under 3.01, C. and as follows.
   5. Priming Blast Cleaned Metal: Prime blast cleaned metal within 24 hours.

6. Primed surfaces, exposed to sunlight for 60 days or more, must be scarified by lightly sanding or whip blasting to assure proper adhesion of final coat(s).
7. If there is a time period in excess of five (5) months from application of a shop or field primer coat to proposed date to apply the first field finished coat, first field finished coat will not be applied. Instead, blast clean primer completely off to obtain the SSPC-SP surface specified for particular application in Painting Systems. Then, reapply primer and finish paint as specified. Cost of removing primer by blast cleaning and reapplying primer will be at no expense to Owner.
8. Terminate shop prime coats on steel six inches from edges that are to be field welded.

B. Ferrous Metal:
   1. Shop or Field Primed for Submerged or Intermittently Submerged in Liquid Service:
      a. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
      b. Except for insides of pipes, blast clean in accordance with SSPC SP 10 or pickle in accordance with SSPC SP 8.
      c. After blast cleaning, remove dust and spent sand from surface by brushing or vacuum cleaning.
      d. Apply prime coat before surface starts to rust or within 24-hours, whichever is earlier.
      e. Do not allow blast cleaned surface to stand overnight before coating.
   2. Not Shop Primed and Non-Submerged:
      a. Grind smooth to a rounded contour sharp edges and welds, and remove weld splatter.
      b. Blast clean in accordance with SSPC SP 6.
      c. After blast cleaning, remove dust and spent sand from surface by brushing or vacuum cleaning.
      d. Apply prime coat before surface starts to rust or within 24-hours, whichever is earlier.
      e. Do not allow blast cleaned surface to stand overnight before coating.
   3. Shop Primed:
      a. Immediately before paint application, clean sand, dust, mud, dirt and other foreign matter from shop coat.
      b. Touch-up damaged or destroyed shop paint.
      c. Surface preparation of surfaces to be touched-up must be as effective as those specified for shop painting.

C. Galvanized Metal Including Pipes and Conduits:
   1. Solvent clean in accordance with SSPC SP 1 all surfaces free of oil and contaminants with a non-petroleum based solvent recommended by the coating manufacturer.
   2. Remove white rust by hand or power tool cleaning in accordance with SSPC SP 2 or SSPC SP 3. Pretreat with conditioner recommended by manufacturer.
   3. Allow to dry before application of paint.

D. Copper Pipe:
   1. Solvent clean with steel wool in accordance with SSPC SP 1.
   2. Pretreat with conditioner recommended by manufacturer.
   3. Allow to dry before application of paint.

E. Shop Bituminous Coated Pipe:
   1. Hand tool clean in accordance with SSPC SP 2.
   2. Wipe or brush clean.
   3. Recoat with compatible bituminous coating.

F. Polyvinyl Chloride Pipe:
   1. Lightly sand off sheen and clean.
   2. Remove dust and sand by wiping with a dry cloth.

G. Concrete:
   1. Remove oil, grease, dirt, etc. by steam cleaning. Non-water bearing walls may be scrubbed with a strong commercial type detergent and flushed with water.
   2. Remove fins, projections, and abrupt irregularities, including those under 1/8-inch, by grinding so unnoticeable transitions are achieved.
   3. Fill exposed aggregate or deep pits and air holes with cement grout and trowel to a uniform surface texture.
   4. Perform work only on cured, clean and dry concrete surfaces.

H. Masonry and Precast Concrete
   1. Clean out cracks, loose mortar, chips, indentations and open pores.
   2. Patch with mortar all depressions.
   3. Perform work only on cured, dry and dust free masonry surfaces.
   4. Apply surfacer recommended by paint manufacturer in accordance with manufacturer's procedures.

I. Wood:
   1. Surfaces must be dry and sanded to a smooth, even finish and wiped clean of dust.
   2. Seal knots with two (2) coats of shellac.
   3. Fill nail holes and other defects with wood filler similar to DAP No. 33 after prime coat has dried. Use color matched putty to fill holes and defects on clear finished wood.

J. Plaster and Gypsum Wallboard:
   1. Patch, sand and seal all rough spots before prime coat.
   2. Touch-up all suction spots and hot spots with primer before application of finished coats.

K. Pipe and Equipment Insulation:
   1. Clean free of dirt, dust, oil, grease, or other foreign matter as recommended by the coating manufacturer for substrate and application required.
   2. Do not cut or damage the insulation in any way.

3.03 RE-PAINT SURFACE PREPARATION

A. Assume complete responsibility for quality of repaint work insofar as proper surface preparation will affect finished appearance. Quality of finishes is subject to Engineer's approval or rejection. Recoat work as a result of rejection will be at no expense to Owner.

B. Prepare previously painted surface where rust, powdering, scaling, peeling or flaking is present by wirebrushing, scraping, sanding and blast cleaning to solid material. Sand solid edges smooth.

C. Prepare hard, glossy, repaint surfaces for paint adhesion by sandpapering, followed by surface washing and rinsing. When a de-glosser is used, washing and rinsing may be eliminated.

D. To avoid rust showing from nails' heads in repaint wood surfaces, countersink nails and fill holes, together with all other crevices, with wood filler similar to DAP 33 after priming coat has dried. Lightly sand wood filler to a smooth surface. Coat knots and sappy spots with shellac before painting.

E. Just prior to application of paint or coatings, re-paint surfaces must be dry, clean and free of loose dirt, dust and grit.

F. Patch test unknown old coatings for compatibility.

3.04 MATERIALS PREPARATION

A. General:
   1. Mix and prepare painting materials in strict accordance with manufacturer's directions.
   2. Do not mix coating materials produced by different manufacturers.
   3. Store materials not in actual use in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in a clean condition, free of foreign materials and residue.
   4. Stir all materials before application to produce a mixture of uniform density, and as required during application of materials. Do not stir any film which may form on surface into material. Remove film and, if necessary, strain material before using.
   5. If material has thickened or must be diluted for application, buildup coating to same film thickness achieved with undiluted material. Do not use thinner to extend coverage of paint.

B. Tinting:
   1. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat. Provide code number that identifies material tinted by manufacturer.

3.05 APPLICATION

A. General:
   1. Strictly follow paint manufacturer's label instructions for proper application, spreading rate and drying time.
   2. Apply paint by brush, roller, air spray, or airless spray in accordance with manufacturer's directions, and recommendations of Paint Application Specifications No. 1 in SSPC Vol. 2, where applicable. Use brushes best suited for type of material being applied. Use rollers of carpet, velvet back, or high pile sheeps wool as recommended by paint manufacturer for material and texture required. Do not use rollers having nap exceeding 3/8-inch.
      a. Apply by brush to newly welded seams.
      b. Apply prime coats by roller, brush, or spray.
   3. Apply paints only when temperature of surfaces to be painted and surrounding air temperatures are between 50 and 95 degrees F, and will remain in this range during curing, unless otherwise permitted by paint manufacturer's printed instructions.
   4. Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or to damp or wet surfaces.
   5. Painting may be continued during inclement weather only if areas and surfaces to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.
   6. Provide adequate illumination and ventilation in areas where painting operations are in progress.
   7. Maintain number of coats and minimum paint film thickness per coat required regardless of application method. Do not apply succeeding coats until previous coat has completely dried or the minimum time recommended by manufacturer elapsed, whichever is longer.
   8. Apply additional coats when undercoats, stains, or other conditions show through the final coat of paint, and until paint film is of uniform finish, color and appearance. This requirement is of particular importance regarding intense primary accent colors. Ensure surfaces, including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.
   9. Surfaces not exposed to view do not require color coding and in some cases do not require painting. See 1.09, C.
   10. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint as specified, before final installation of equipment.
      a. Paint backs of access panels, and removable or hinged covers to match exposed surfaces.
      b. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces, unless otherwise specified.
      c. Do not apply paint over sealants and caulking compounds until integral solvents have been released from compound. Conform to sealant and caulking manufacturer's recommendations.
      d. Paint existing structural steel to match new structural steel.
      e. Spray painting of sound-absorbing concrete masonry units containing sound insulation material is prohibited. This requirement prevents insulation

material from being sprayed, resulting in a consequent loss of sound attenuation effectiveness. Apply paint on sound-absorbing masonry by rolling or brushing.

f. Sprayed Finishes: Spray paint finish doors, frames and windows, where required. Brush or roller finishes will not be acceptable.

g. Install piping markers and safety signs only after painting and finish work is completed.

B. Minimum Coating Thickness: Apply each material at not less than the manufacturer's recommended spreading rate, and provide total dry film thickness as specified. In no case allow area coverage per gallon to exceed manufacturer's recommendations. Apply extra coat at no additional expense to obtain specified total dry film thickness.

C. Scheduling Painting:

1. Apply first-coat material to surfaces that have been cleaned, pretreated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
   a. Apply primers before rust bloom forms but in no case allow cleaned steel to be exposed for more than 24-hours.
2. Allow sufficient time between successive coatings to permit proper drying. Do not recoat until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and application of another coat of paint does not cause lifting or loss of adhesion of undercoat. In no case apply an additional coat until manufacturer's minimum recommended drying time between coats has elapsed.

D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to assure a finish coat with no burn-through or other defects caused by insufficient sealing.

E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

F. Brush Application:

1. Brush-out and work all brush coats onto surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are not acceptable. Neatly draw all glass and color break lines.
2. Brush apply all primer or first coats, unless otherwise permitted to use mechanical applicators.

G. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not in compliance with specified requirements as required by Engineer.

H. Placing Into Service: Do not place painted items into service until paints and coatings are fully cured (dry-hard).

I. Piping Markers and Safety Signs: Apply piping markers in accordance with manufacturer's written instructions and in locations specified. Apply safety signs at locations directed by Engineer.

3.06 FIELD QUALITY CONTROL

A. Engineer reserves right to invoke following material testing procedure at any time, and any number of times during the period of field painting:
   1. Engage the service of an independent testing laboratory to sample any paint being used. Samples of materials delivered to Project site will be taken, identified and sealed, and certified in presence of Contractor.
   2. Have independent testing laboratory perform appropriate tests for any or all of following characteristics: abrasion resistance, apparent reflectivity, flexibility, washability, absorption, accelerated weathering, dry opacity, accelerated yellowness, recoating, skinning, color retention, alkali resistance, quantitative materials analysis, and compatibility of coatings.
   3. If test results show that material being used does not comply with specified requirements, a directive may be made, at no expense to Owner, to stop painting work and remove noncomplying paint; pay for testing; repaint surfaces coated with rejected paint; remove rejected paint from previously painted surfaces if, upon repainting with specified paint, the two (2) coatings are noncompatible.

B. Notify Engineer after completion of each coat of paint. After inspection, checking of film thickness, and approval by Engineer, proceed with succeeding coat. Supply Engineer for his use a Gardner dry-film thickness gage.

C. During application of painting, have manufacturer's representative check dry mil thickness of each coating and certify to Engineer in writing that thickness is in compliance with Specifications. If deficiencies in dry mil thickness of any coat is found, correct by application of an additional coat(s) to deficient area at no additional expense. Manufacturer's representative is also to certify that all surfaces were properly cleaned prior to application of paint, specified meetings and inspections were made; quantity of paint was applied in accordance with their recommendations, and all other requirements stated in this Section were satisfactorily completed.

3.07 PROTECTION

A. Protect work of other trades against damage caused by painting and finishing work. Correct damages by cleaning, removing paint splatter, repairing or replacing, and repainting, as acceptable to Engineer.

B. Provide "Wet Paint" signs as required to protect newly painted finishes. Remove temporary protective wrappings provided after completion of painting operations.

C. Protect painted surfaces from damage. Touch up and restore damaged or defaced painted surfaces as determined by Engineer.

3.08 CLEANING

A. During progress of Work, remove from site all discarded paint materials, rubbish, cans and rags at end of each work day.

B. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

C. Remove paint from existing structures, road surfaces, piping and other facilities which were not to be painted.

D. At completion of work of other trades, touch up and restore damaged or defaced painted surfaces as determined by Engineer.

PAINT SCHEDULE			
Surface	Number of Coats	Coating System	Minimum Dry Mil Thickness
CONCRETE			
All interior exposed cast in place reinforced concrete ceilings and precast concrete roof members.	1 Prime Coat	Tnemec N69 or N69F-1255	4.0 - 6.0 mils
	1 Finish Coat	Tnemec N69 or N69F-11WH	4.0 - 6.0 mils
Epoxy Floor Coating where scheduled on Drawings. Allow new concrete to cure 28 days and acid etch prior to topcoating.	1 Prime Coat	Tnemec 287-32GR	3.0-5.0 mils
	1 Finish Coat	Tnemec 290/291/297-32GR	2.0-3.0 mils
All interior concrete walls in contact with water on one side and exposed to an occupied room or area on the other side. Apply coatings to water bearing walls on side in contact with water only.	1 Prime Coat	Tnemec N140-1255[4]	4.0-6.0 mils
	1 Finish Coat	Tnemec N140-15BL[4]	4.0-6.0 mils
Concrete floors of filter influent flume and sedimentation basin, filter walls, flume divider walls and flume end walls.		See Section 09961	
Concrete floors and walls in polymers containment areas and Trench Drain No. 2	1 Prime Coat	Tnemec N69 or N69F	4.0 - 6.0 mils
	1 Finish Coat	Tnemec N69 or N69F	4.0 - 6.0 mils
Concrete floors and walls in chemical containment areas, and inside surface of chemical manholes and trench drain No 1.		See Section 09967	

MASONRY			
All interior exposed masonry wall surfaces.	1 Filler Coat	Tnemec 54-562 Off White	75-90 SF per gallon
	1 Prime Coat	Tnemec N69 or N69F-11WH	3.0-4.0 mils
	1 Finish Coat	Tnemec N69 or N69F Color	3.0-4.0 mils
All exterior exposed masonry wall surfaces, except brick and pre-cast stone.	1 Prime Coat	Tnemec 181-Color	6.0-8.0 mils
	2 Finish Coats	Tnemec 181-Color	6.0-8.0 mils per coat
GYPSUM WALLBOARD			
	1 Primer Coat	Tnemec 51-792	1.5 mils
	2 Finish Coats	Tnemec 113-Color	2.0-3.0 mils per coat
NON-SUBMERGED METAL (NON-INSULATED) (INTERIOR)[1]			
All exposed ferrous metals inside plant including, but not necessarily limited to, mechanical equipment; pumps; motors; piping; valves; fittings; supports; hangers; exposed structural steel; gratings; stairs; windows; doors; and exposed electrical conduit and HVAC ducts located on walls and ceilings.	1 Shop Coat	Tnemec N69 or N69F-1255	3.0 - 5.0 mils
	1 Field Prime Coat	Tnemec N69 or N69F-32GR	3.0 - 4.0 mils
	1 Finish Coat	Tnemec N69 or N69F-Color	3.0 - 4.0 mils
NON-SUBMERGED METAL (EXTERIOR)[1]			
All exposed ferrous metals outside plant including, but not necessarily limited to, doors; structural steel; and exposed valve operators.	1 Shop Coat	Tnemec N69 or N69F-1255	3.0 - 4.0 mils
	1 Field Prime Coat	Tnemec N69 or N69F	3.0 - 4.0 mils
	1 Intermed. Coat	Tnemec N69 or N69F - Color	3.0 - 4.0 mils
	1 Finish Coat	Tnemec 1075-Color	2.0 - 3.0 mils

STRUCTURAL STEEL (CONCEALED)			
	1 Shop Coat	Tnemec 37H-77	1.5 - 2.0 mils
	2 Contact Surface Coats	Tnemec 46-465[2]	6.0 - 8.0 mils per coat
ALUMINUM (CONTACT SURFACE)			
Aluminum surfaces in contact with concrete, masonry, or dissimilar metals. All exposed aluminum surfaces are not to be painted	2 Contact Surface Coats	Tnemec 46-465[2]	3.0-4.0 mils per coat
ALL COPPER PIPE[1]			
	2 Coats	McCloskey's Man-O-War Marine Spar Varnish	2.0 - 3.0 mils
SUBMERGED METAL			
All submerged ferrous metal including piping and mechanical equipment, including, but not limited to, pipe, and valves.	1 Shop Coat	Tnemec Series 1[4]	2.5 - 3.5 mils
	1 Field Prime Coat	Tnemec Series 1[4]	2.5 - 3.5 mils
	2 Finish Coats	Tnemec N140-Color[4]	4.0-6.0 mils per coat
INSULATED PIPING AND EQUIPMENT			
Non-galvanized ferrous metal piping including, but not limited to, pipe, fittings, and valves (Valve Operators per interior non-submerged.)	2 Coats	Tnemec 46-465	4.0-6.0 mils per coat
Insulation material	[3]	[3]	[3]
BURIED METALS			
Outside surface of all ferrous metals embedded in earth, excluding pipe, fittings, and valves.	2 Coats	Tnemec 46-465	8.0 mils per coat
OUTSIDE SURFACE OF BURIED PIPING, FITTINGS AND VALVES			
Outside surface of all buried ductile iron pipe and fittings		Asphaltic coating in accordance with AWWA C151 Specifications	1.0 mil per coat
Valves		Epoxy coating in accordance with AWWA C550	

INSIDE SURFACE OF ALL PIPING, VALVES AND METERS (unless specified differently for a particular type of pipe, valve or meter)			
Inside surface of all ferrous pipe and fittings which are not cement lined		Asphaltic coating in accordance with AWWA C104 Specifications[4]	1.0 mil per coat
Sealer for cement lined pipe		Asphaltic coating in accordance with AWWA C104 Specifications[4]	1.0 mil per coat
Valves and Meters		Epoxy coating in accordance with AWWA C550[4]	
POLYVINYL CHLORIDE (PVC) PIPE			
	1 Coat	Tnemec N69 or N69F-Color	2.0 - 3.0 mils
OUTSIDE CEMENT PLASTER			
	1 Primer Coat	Tnemec 151	1.0 - 1.5 mils
	2 Finish Coats	Tnemec 180 Color	4.0 - 6.0 mils per coat
WOOD			
Interior	1 Primer Coat	Tnemec 151	1.0 - 1.5 mils per coat
	2 Finish Coats	Tnemec 28 or 29-Color	2.0 - 3.0 mils per coat

[1] Galvanized metal shall receive one (1) coat of Great Lakes Clean N'Etch or approved equal pretreatment prior to the application of the primer and finish coats. Copper tubing and other non-ferrous metals shall receive one (1) coat of Great Lakes Clean N'Etch or approved equal product, prior to being cleaned with steel wool and the application of the primer and finish coats. The wash treatment shall include applying the Great Lakes Clean N'Etch and wiping it off in accordance with the manufacturer's instructions. The primer shall be applied within 24 hours after the wash treatment

[2] The contact surface of the dissimilar metal may be given two brush coats of N69 or N69F primer instead of the two (2) coats of coal-tar.

[3] Latex paint system approved by insulation manufacturer.

[4] Coatings must be NSF61 approved.

PIPING COLOR SCHEDULE	
WATER LINES	
Raw	Olive Green (21GN)
Settled or Clarified	Aqua (39BL)
Finished or Potable	Dark Blue (10SF)
CHEMICAL LINES	
Alum or Primary Coagulant	Orange (04SF)
Ammonia	White (11WH)
Carbon Slurry	Black (35GR)
Caustic	Yellow with Green Band (02SF/09SF)
Chlorine (Gas and Solution)	Yellow (02SF)
Flouride	Light Blue with Red Band (37BL/02SF)
Lime Slurry	Light Green (37GN)
Ozone	Yellow with Orange Band (02SF/04SF)
Phosphate Compounds	Light Green with Red Band (37GN/06SF)
Polymers or Coagulant Aids	Orange with Green Band (04SF/09SF)
Potassium Permanganate	Violet (14SF)
Soda Ash	Light Green with Orange Band (37GN/04SF)
Sulfuric Acid	Yellow with Orange Band (02SF/04SF)
Sulfur Dioxide	Light Green with Yellow Band 37GN/02SF
WASTE LINES	
Backwash Waste	Light Brown (40BR)
Sludge	Dark Brown (84BR)
Sewer (Sanitary or Other)	Dark Gray (33GR)
OTHER	
Compressed Air	Dark Green (09SF)
Gas	Red (06SF)
Other Lines	Light Gray (32GR)
Other Lines	Light Gray (32GR)

END OF SECTION

SECTION 09961

ELASTOMERIC COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Liquid applied, membrane coating system components and application schedule.

B. Related Work Specified Elsewhere:
   1. Products: Section 01600.
   2. Cast-In-Place Concrete: Section 03300.

1.02 REFERENCES

A. American National Standards Institute:
   1. ANSI/NSF Standard 61 Listing of Certified Drinking Water System Components - Health Effects.

B. American Society for Testing Materials:
   1. ASTM B117, Standard Test Method of Salt Spray Fog Testing.
   2. ASTM D638, Standard Test Method for Tensile Properties of Plastics.
   3. ASTM D1653, Standard Test Method for Water Vapor Transmission of Organic Coating Films.
   4. ASTM D2240, Rubber Properties - Durometer Hardness.
   5. ASTM D2370, Standard Test Method for Tensile Properties of Organic Coatings.
   6. ASTM D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Defomation.
   7. ASTM D3170, Standard Test Method for Chipping Resistance of Coatings.
   8. ASTM D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   9. ASTM D4541, Standard Test Method for Pull-off Strength of Coatings Using Portable Adhesive Testers.

C. Steel Structures Painting Council:
   1. Surface Preparation Specifications:
      a. SSPC-SP 6, Commercial Blast Cleaning.
      b. SSPC-SP 10, Near-White Blast Cleaning.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Ensure surfaces are properly prepared and membrane is applied in strict accordance with manufacturer's written instructions and to correct mil thickness.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive product data, current specifications and application instructions.

B. Quality Assurance/Control Submittals:
   1. Applicator Qualifications: Submit reference letters, crew and supervisor names, and product manufacturer's letter stating applicator has prior satisfactory experience using product as outlined under Quality Assurance Article below.

C. Certificates: Submit certification of NSF 61 approval.

1.05 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Applicator to be approved by product manufacturer.
   2. Applicator to provide crew supervisor and majority of work crew during all phases of work.
   3. Employ applicator with experience on at least three prior projects applying liquid membrane system.
   4. Submit names of supervisor and crew members of applicator to Engineer.
   5. Applicator to provide signed and dated letters of reference from three liquid membrane system projects that supervisor completed successfully. Project references must substantiate that supervisor provided quality workmanship and satisfactorily completed work on referenced project.

B. Pre-Installation Meeting:
   1. Prior to application of membrane, arrange a meeting between a representative of manufacturer, Engineer and Contractor's personnel involved in application. Purpose of meeting is to have representative:
      a. Inspect surfaces to receive membrane and advise of surface preparation requirements.
      b. Review product applicability and installation procedures.
      c. Answer questions.
   2. Have product manufacturer provide a technical representative on site for first day of application.
   3. Applicator to provide for use of crew and Engineer, a moisture meter as manufactured by Tramex, Concrete Moisture Encounter and wet film gauges up to 100 mils.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle membrane coating components in accordance with Section 01600, manufacturer's recommendations, and as supplemented below.

B. Delivery of Materials:
   1. Deliver materials to job site in original, new, unopened packages and containers bearing manufacturer's name and label with following information:

a. Name or title of material.
b. Manufacturer's stock number and date of manufacture.
c. Manufacturer's name.
d. Contents by volume, for major pigment and vehicle constituents.
e. Thinning instructions where recommended.
f. Application instructions.

C. Storage of Materials:
1. Store materials in accordance with manufacturer's recommendations including temperature restrictions.
2. Store only acceptable materials on Project site.
3. Store in suitable location approved by Engineer. Keep area clean and accessible.
4. Store materials in original, tightly sealed containers or unopened packages clearly labeled with manufacturer's name, brand name and number and batch number of material where appropriate.
5. Store materials in a neat and safe manner. Do not exceed allowable live load of storage area.
6. Protect materials from weather and contamination from dirt, debris, moisture, etc.
7. Store liquid materials, such as adhesives, thinners and primers in areas away from sparks, open flames and excessive heat.

1.07 PROJECT CONDITIONS

A. Environmental Requirements:
1. Do not commence or proceed with application of liquid applied membrane coating during inclement weather, or threat of imminent precipitation, unless work area is enclosed or otherwise protected from weather.
2. Ensure surfaces to receive system are thoroughly dry and free of dew or frost, and have cured for a minimum of 28 days. Provide a moisture meter, Tramex Concrete Encounter as supplied by Paul N. Gardner Company, Inc., Pompano Beach, FL, to ascertain the moisture content in concrete is 5 percent or less before commencing work.
3. Application temperatures are limited and must be in conformance with manufacturers recommendations.
4. Prior to application, remove dirt and dust from surfaces by vacuuming, sweeping, or blowing with compressed air or similar methods.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide either of the following membrane coating system types, however a mixture of the two types in the Project is not permitted.

2.02 POLYUREA ELASTOMER MEMBRANE COATING SYSTEM

A. Minimum Physical Properties:
   1. Abrasion (CS17 Wheel, 1000 gram load): No more than 15 mg loss, average of three trials per ASTM D4060.
   2. Adhesion: Not less than 933 psi pull, average of three trials per ASTM D4541.
   3. Chip resistance: No chipping or cracking of coating per ASTM D3170.
   4. Tensile Strength and Elongation: Not less than 4,726 lbs/in tensile strength and 644% elongation per ASTM D2370.
   5. Fresh Water Immersion: Continuous immersion- No blistering, cracking, rusting or delamination of film after 4000 hours continuous immersion.
   6. Hardness: Not less than a Shore hardness of 46 per ASTM D2240.
   7. Salt Spray Fog: No blistering, cracking, rusting or delamination of film. No rust creepage at scripe after 5000 hours exposure per ASTM B117.
   8. Tear Strength: Not less than 546 inch-pounds tear strength per ASTM D638.
   9. Impact: Not visible cracking or delamination after 160 in/lbs direct and indirect impact per ASTM D2794.
   10. Water Vapor Transmission (Method A–Wet Cup, 75 degrees F): No more than 17.8 g/m2/24h water vapor transmission, average of three trials. No more than 0.893 g/m2/24h/mm Hg water vapor permeability, average of three trials per ASTM D1653:

B. Components
   1. Concrete: Aggregate reinforced epoxy filler/surfacer-Tnemec series 218.
   2. Concrete/Steel: Prime Coat: Modified Polyamine Epoxy-Tnemec series 201.
   3. Liquid Membrane: Polyurea Elastomer- Tnemec series 400.
   4. Reinforcing Fabric: Polyester fabric approved by liquid membrane manufacturer. Provide fabric with minimum weight of 3 ounces per square yard.

C. Joint Cover Sheet:
   1. Polyester Scrim: 3.00 oz./square yard 6-inch to 12-inch wide polyester designed for compatibility with liquid membrane, supplied by liquid membrane manufacturer and applied according to their Specifications.
   2. Tape: Reinforced non-porous tape applied to joints as indicated in execution section of this Specification.

D. Manufacturer:
   1. Tnemec Company, Elasto Shield MPL.

PART 3 EXECUTION

3.01 APPLICATION TOOLS AND EQUIPMENT

A. Application equipment is not required to be new, but be adequate for intended job and have been successfully used on prior applications of material on similar surfaces, surface orientations and surface dimensions.

3.02 EXAMINATION

A. Examine areas and conditions where membrane coating work is to be performed and notify Engineer in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions are corrected in a manner acceptable to Engineer.

B. Do not apply coating over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable membrane film.

C. Properly mask or otherwise protect surfaces not designed to receive system, against accidental spillage or application of materials.

3.03 SURFACE PREPARATION

A. Ensure surfaces are free of contaminants such as, but not limited to, asphalt, oil, paint, grease, scale, cement laitences, curing compounds and similar materials.
   1. Concrete: Blast clean surfaces to remove laitence, curing compounds, release agents, and surface contaminants. Remove loose material and sharp edges by blast cleaning. Prepared surface to be free of holes and appear smooth. Repair defects in concrete surface, such as bug holes, air pockets and/or honeycomb following methods stated in Section 03300.
   2. Steel: Surfaces to be free of oil or grease spots, loose rust or rust residue, and dirt. Do not apply liquid membrane over steel that is blistered or flaking. For primed steel, scarify surface by blast cleaning before coating.
      a. For Immersion Service: Near-White Metal Blast, SSPC-SP 10.
      b. For Non-Immersion Service: Commercial Blast, SSPC-SP 6.
   3. Other Metals: Aluminum, copper, brass, zinc, etc. to be roughened by light blast cleaning, sanding, or abrasive cleaning. Eliminate smooth, glossy metal surfaces to provide adhesion.
   4. PVC: Roughen surface with sandpaper, apply coating system over pipe. Use hose clamp when dry and recoat over hose clamp.

3.04 JOINTS, CRACKS AND EDGES

A. Polyurea Elastomer Membrane Coating System: Apply a 12-inch wide strip of polyester scrim at all joints, cracks and at edges (vertical joints where walls join and joints at walls and floors).
   1. Center scrim over joints and adhere by first applying a tack coat of fluid membrane.Prepare in accordance with manufacturer's recommendations.
   2. Prime coat of Tnemec series 201.

3.05 MIXING OF LIQUID APPLIED MEMBRANE (TWO COMPONENT MATERIAL)

A. Provide a plaster mixer, Jiffy Mixer or mixing wand, using a 1/2 inch power drill, to thoroughly blend components for 3 full minutes. Hand mixing of components not allowed.

3.06 SAFE PRACTICES

A. Use equipment and procedures designed to minimize danger to personnel and materials, and meeting state and federal guidelines for worker safety. Provide ventilation and respirators for personnel applying liquid membrane systems in enclosed areas. Adequate protection and ventilation is sole responsibility of applicator.

3.07 APPLICATION OF MEMBRANE

A. Polyurea Elastomer Membrane Coating System:
   1. Filler/Surfacer: Tnemec series 218 @ 1/16 inch trowel applied
   2. Prime Coat: Tnemec series 201 @ 6-12 mils DFT
   3. Finish Coat: Tnemec Series 400 @ 30-40 mils DFT

B. No phase of this construction is to take place if any one or more of following conditions exist:
   a. Material temperature at time of application is below 60 degrees F. (15 degrees C.).
   b. Surface temperature is below 40 degrees F. (10 degrees C.).
   c. Surface moisture is present or rain is imminent.
   d. Surface temperature drops below dew point.
   e. Surface temperature of concrete is within 5 percent of the dewpoint (including direct sun on surface).
   f. Other conditions as identified by Engineer or manufacturer's representative which are obviously unsuitable.

C. Apply membrane to fiberglass weir plate guides or sluice gate thimbles only to extent to ensure a watertight structure. Do not coat surfaces where weir plates run or gates operate.

3.08 CURING

A. Non-Immersion Service: Initial cure in 3 to 4 hours. Fully cured in 24 hours at 77 degrees F.

B. Immersion Service: For potable water service 14 days but highly temperature dependent. Consult product manufacturer for actual curing times at temperatures other than 60 degrees F. Curing time is also dependent on residual solvents released after immersion. Refer to water testing article for further details.

3.09 WATER TESTING

A. Water test all membrane coated areas.

B. Do not water test any area until after proper curing time.

C. Water testing includes filling of entire vessel either by section or entirely for a minimum period of 24 hours.

D. Drain any area where leaks or damp spots occur. Thoroughly dry, repair, and retest until approved.

E. At end of 24-hour water test period, remove three water samples from test area. Take water samples in areas designated by Engineer. Test samples for all currently regulated or proposed to be regulated volatile organic compounds in accordance with currently accepted EPA methods published in 40 CFR part 141 and EPA 600/4-79-020. Measured levels not to exceed 10 percent of Maximum Contaminate Level (MCL) for VOC's as established by National Primary Drinking Water Standard. Testing which does not meet 10 percent of MCL will be retested. If further retests are not satisfactory, make corrective actions to membrane to comply with 10 percent of MCL at no cost to Owner.

F. Surface Cleaning Prior to Disinfection: Scrub with a long handle bristle brush or high pressure wash using an acceptable detergent or a 1/2 percent acetic solution. Remove wash solution and follow with a rinse of clean water which also is to be removed. Follow with normal disinfection procedures.

3.10 CLEANUP

A. Upon completion of coating system, remove all masking, protection, equipment, material and debris from work and storage area, and leave areas in an undamaged and acceptable condition.

3.11 PROTECTION

A. Protect coated work, work areas and adjacent work and materials by suitable coverings, barricades, signs or other protective methods.

B. Upon completion of application and cleanup, keep membrane free of traffic and other trades. If traffic becomes absolutely necessary due to unforeseen circumstances, lay protection board on membrane before traffic is permitted. Type of protection board is subject to approval by Engineer.

3.12 MEMBRANE COATING SCHEDULE

A. Filter Influent Flume: Coat entire floor of flume and sedimentation basin and filter walls to point 2 feet above floor. Coat flume divider walls to point 2 feet above floor. Coat entire end walls for their full height at either end of flume.

3.13 WASTE MANAGEMENT

A. Do not dispose of paints or solvents by pouring on the ground. Place in designated containers for proper disposal.

B. Where paint recycling is available, collect all waste paint by type and provide for delivery to recycling or collection facility.

END OF SECTION

SECTION 09967

CHEMICAL RESISTANT COATINGS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Chemical resistant coating systems and application schedule.

B. Related Sections:
   1. Products: Section 01600.
   2. Cast-In-Place Concrete: Section 03300.

1.02 REFERENCES

A. American Society for Testing Materials:
   1. ASTM D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
   2. ASTM D638, Standard Test Method for Tensile Properties of Plastics.
   3. ASTM D790, Standard Test Method for Flexural Properties of Un-reinforced and Reinforced Plastics and Electrical Insulating Materials.
   4. ASTM D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   5. ASTM D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation.
   6. ASTM D4541, Standard Test Method for Pull off Strength of Coatings Using Portable Adhesion Testers.

B. American Water Works Association (AWWA):
   1. AWWA C210, Standard for Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.

1.03 SYSTEM DESCRIPTION

A. Performance Requirements:
   1. Liquid Applied, Polyamine Fiber-Reinforced Novolac Epoxy Membrane Lining System:
      a. Minimum Physical Properties:
         1) Adhesion: No less than 508 PSI Pull, average of three tests per ASTM D4541.
         2) Flexural Strength and Modulus of Elasticity: No less than 8644 PSI (59.60 MPa) flexural strength and 293,000 psi (2020 MPa) flexural modulus of elasticity, average of three tests per ASTM D790.
         3) Hardness: (Shore D). No less than 90 type D hardness per ASTM D2240.
         4) Impact: No less than 130 inch pounds (15 J), direct impact per ASTM D2794.

5) Rate of Burning: No more than 6.2 cm/min rate of burning, average of three tests per ASTM D635.
6) Tensile Strength and Tensile Modulus of Elasticity: No less than 3,424 psi (23.61 MPa) tensile strength and 183,500 psi (1,265 MPa) tensile modulus of elasticity, average of six tests per ASTM D638.

2. Cycloaliphatic Amine Epoxy:
   a. Conforms to performance requirements of AWWA C210.

1.04 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive product data, current specifications and application instructions.

B. Applicator Data: Product manufacturer's letter stating that the applicator has prior satisfactory experience using the product as outlined under Quality Assurance article.

1.05 QUALITY ASSURANCE

A. Product:
   1. The materials specified in this Section are as manufactured by Tnemec Company, Kansas City, MO. These materials are designated as a "standard of quality".
      a. Any substitutes are to be a standard, regularly produced product of a manufacturer, submitted for approval in accordance with Section 01600.
      b. Manufacturers of substitutes to submit full and complete written instructions to the applicator indicating in detail all aspects of the product and its installation.

B. Applicator:
   1. Work to be completed by a competent applicator, in a manner conducive to good workmanship and overall completion of the requirements of these specifications. Applicator is to be approved by the product manufacturer. Submit a letter stating such with the shop drawing submittals.
   2. Applicator to provide a crew supervisor and a majority of the work crew, during all phases of the work, with experience on at least three prior projects in applying the liquid membrane system. Applicator to provide the names of the supervisor and crew members with the shop drawings for the product data. Applicator to provide signed and dated letters of reference from three liquid membrane system projects that supervisor completed successfully. Project references must substantiate that supervisor provided quality workmanship and satisfactorily completed work on the referenced project.
   3. Materials to be mixed, thinned, modified and applied only as directed by the manufacturer and as outlined in the latest written application instructions.
   4. Applicator to protect his work and work areas as well as adjacent work and materials by suitable coverings, barricades, signs or other protective methods.

C. Product Manufacturer's Representative:
   1. Prior to the application of the membrane, arrange a meeting between a representative of the manufacturer, the Engineer and the Contractor's personnel involved in the application. The purpose of the meeting is to have the representative:
      a. Inspect surfaces to receive the membrane and advise of surface preparation requirements.
      b. Review product applicability and installation procedures.
      c. Answer questions.
   2. Product manufacturer to provide a technical representative on the site for the first day of application.

D. It is the Contractor's responsibility to ensure that all surfaces are properly prepared and that the membrane is applied in strict accordance with the manufacturer's written instructions and to the correct mil thickness.

1.06 DELIVERY, STORAGE AND HANDLING

A. Store all materials in their original tightly sealed containers or unopened packages; clearly labeled with the manufacturer's name, brand name and number and batch number of the material where appropriate.

B. Store materials in a neat and safe manner so as not to exceed the allowable live load of the storage area.

C. Materials are to be protected from weather and contamination from dirt, debris, moisture, etc. Store all materials in accordance with manufacturer's recommendations including temperature restrictions.

D. Store liquid materials, such as adhesives, thinners and primers in areas away from sparks, open flames and excessive heat.

1.07 PROJECT CONDITIONS

A. No application of liquid applied urethane membrane is to commence or proceed during inclement weather, or the threat of imminent precipitation, unless the work area is enclosed or otherwise protected from the weather.

B. All surfaces to receive the system are to be thoroughly dry and free of dew or frost and have been cured for a minimum of 28 days. Use a moisture meter showing moisture content in concrete is 5 percent or less.

C. Application temperatures are limited and are to be in conformance with manufacturers recommendations.

D. Prior to application, remove all dirt and dust from surfaces either by vacuuming, sweeping, blowing with compressed air or similar methods.

E. Surfaces not designed to receive the system are to be properly masked or otherwise protected against accidental spillage or application of the materials to those areas.

F. The minimum dry film thickness is to be the minimum recommended by the manufacturer for this application, but in no case is it to be less than 55 mil.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. Tnemec Company, 6800 Corporate Drive, Kansas City, MO, 64120

2.02 LIQUID APPLIED, POLYAMINE FIBER-REINFORCED NOVOLAC EPOXY MEMBRANE LINING SYSTEM

A. Filler/Surfacer: High performance, aggregate reinforced epoxy, modified cement, for surfacing, patching voids and bug-holes in concrete surfaces.
   1. Filler/Surfacer: Tnemec Series 218.

B. Primer: Used as a prime coat on dry, porous surfaces (e.g. concrete, wood) and to ensure a continuous and uniform bond between surfaces, and supplied by the liquid membrane manufacturer and applied according to their specifications.
   1. Prime Coat: Tnemec Series 201.

C. Liquid Membrane: Two-component Polyamine, Fiber-Glass Reinforced, Novolac Epoxy. The coating may be spray applied or trowel applied to form a seamless, monolithic, coating system.
   1. Intermediate: Tnemec Series 275.
   2. Finish Coat: Tnemec Series 282.

2.03 CYCLOALIPHATIC AMINE EPOXY

A. Primer: Self Priming.
   1. Prime Coat: Tnemec Series 104.

B. Finish Coat: Tnemec Series 104.

PART 3 EXECUTION

3.01 APPLICATION TOOLS AND EQUIPMENT

A. Application equipment is not required to be new, but is to be adequate for the intended job and have been successfully used on prior applications of the material on similar surfaces, surface orientations and surface dimensions.

3.02 EXAMINATION

A. Site Verification of Conditions:
   1. No phase of this construction is to take place if any one or more of the following conditions exist:
      a. Material temperature at the time of application is below 60 degrees F. (15 degrees C.).
      b. Surface temperature is below 55 degrees F. (10 degrees C.).
      c. Surface moisture is present or rain is imminent.
      d. Surface temperature is within 5 degrees of the dew point.
      e. Surface temperature of concrete is in a temperature-rising mode (including direct sun on surface).
      f. Other conditions as identified by the Engineer or manufacturer's representative which are obviously unsuitable.

3.03 SURFACE PREPARATION

A. Surfaces to be free of contaminants such as, but not limited to, asphalt, oil, paint, grease, scale, cement laitences, curing compounds and similar materials. Abrasive blast or mechanically abrade surface to remove surface contaminants and create profile.
   1. Concrete: Blast all surfaces to receive the liquid membrane system, using acceptable blast media, to remove laitence, curing compounds, release agents, and surface contaminants including, among others, oil, grease, mud and dirt to obtain ICRI CSP 4-6. Remove all loose material and sharp edges by blasting. Surface is to be free of holes and appear smooth. Repair defects in the concrete surface, such as bug holes, air pockets and/or honeycomb following the methods stated in Specification Section 03300.

3.04 MIXING OF LIQUID APPLIED MEMBRANE (Two Component Material)

A. Coatings to be blended and intimately mixed, using a power mixer, with all components immediately before application.

B. Use a plaster mixer, Jiffy Mixer or mixing wand, using a 1/2 inch power drill to thoroughly blend the two components for 3 full minutes.

C. Hand mixing of the 2 components is not allowed.

3.05 SAFE PRACTICES

A. Use equipment procedures designed to minimize danger to personnel and materials. Special attention should be made to provide adequate ventilation and respirators for personnel applying liquid membrane systems in enclosed areas meeting all state and federal guidelines for worker safety. Adequate protection and ventilation is the sole responsibility of the applicator.

3.06 APPLICATION OF LIQUID APPLIED, POLYAMINE FIBER-REINFORCED NOVOLAC EPOXY SYSTEM

A. Concrete:
   1. Filler/Surfacer: Tnemec series 218 @ 1/16" (1.6mm) trowel applied
   2. Prime Coat: Tnemec series 201 @ 6.0-12.0 mils DFT
   3. Intermediate: Tnemec series 275 @ 25-40 mils DFT
   4. Finish Coat: Tnemec series 282 @ 6.0-12.0 mils DF

3.07 APPLICATION OF CYCLOALIPHATIC AMINE EPOXY

A. Concrete:
   1. Prime Coat: Tnemec series 104 @ 6.0-8.0 mils.
   2. Finish Coat: Tnemec series 104 @ 8.0-10.0 mils

B. Abrade surface if maximum recoat time is exceeded.

C. First coat to be sprayed and backrolled.

3.08 CLEANUP

A. Upon completion of the system, remove all masking, protection, equipment, material and debris from the work and storage area and leave those areas in an undamaged and acceptable condition.

3.09 PROTECTION

A. Upon completion of application and cleanup, keep membrane free of all traffic and other trades. If such traffic becomes absolutely necessary due to unforeseen circumstances, lay a protection board on the membrane before any traffic is permitted. The type of protection board is subject to approval by the Engineer.

3.10 CHEMICAL RESISTANT COATING SCHEDULE

A. Liquid Applied, Polyamine Fiber-Reinforced Novolac Epoxy Membrane Lining System:
   1. Concrete Floors and Walls in Containment Areas (for containment of ferric chloride, hydrofluosilicic acid, polyaluminum chloride, caustic soda, corrosion inhibitor, chemical manholes, spill containment valve manhole, and Trench Drain No. 1.

B. Cycloaliphatic Amine Epoxy:
   1. Concrete Floors and Walls in Containment Areas (for, sodium thiosulfate, and ammonia hydroxide).

3.11 WASTE MANAGEMENT

A. Do not dispose of paints or solvents by pouring on the ground. Place in designated containers for proper disposal.

B. Where paint recycling is available, collect all waste paint by type and provide for delivery to recycling or collection facility.

END OF SECTION

SECTION 11005

BASIC EQUIPMENT MATERIALS AND METHODS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: General requirements for materials, equipment, and installations necessary for complete and satisfactory performance of process equipment work indicated on Drawings and specified in Division 11, Division 13 and Division 14.

B. Related Sections:
   1. Testing Process Systems: Section 01669..
   2. Metal Fabrications: Section 05500.
   3. Paints and Coatings: Section 09900.
   4. Division 11 - Equipment.
   5. Division 13 - Special Construction.
   6. Division 14 - Hoists and Cranes.

1.02 REFERENCES

A. Steel Structures Painting Council:
   1. Paint Application Specifications:
      a. SSPC-PA 1, Shop, Field and Maintenance Painting.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A320, Alloy-Steel Bolting Materials for Low-Temp Service.

C. American Institute of Steel Construction, Inc. (AISC).

D. Federal Specifications (Fed. Spec.):
   1. Fed. Spec. FF-S-325, Shield, Expansion, Nail, Expansion, and Nail, Drive Screw.

1.03 SUBMITTALS

A. Shop Drawings:
   1. 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 specified in each Section of Division 11.
   2. Submit shop drawings certified for construction by manufacturer and approved by Contractor which includes location of electrical connections; wiring diagrams; 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.

B. Installation Certificates: Furnish in accordance with these Specifications manufacturer's installation certificates for following:
   1. Wedge Wire Intake Screens and Air Burst System
   2. Slide Gates
   3. Horizontal Mounted End Suction Centrifugal Pumps
   4. Vertical Turbine Pumps
   5. Chemical Transfer Pumps
   6. Sample Pumps
   7. Non-clog Centrifugal Pumps
   8. Progressive Cavity Pumps
   9. Sludge Collection Equipment
   10. Fiberglass Weir Plates, Troughs, Stop Plates and Guides
   11. Flocculation Equipment
   12. Clarification Equipment
   13. Plate Settlers
   14. Rapid Mixing Equipment
   15. Volumetric Chemical Feed Equipment
   16. Liquid Polymer Feed Equipment
   17. Chemical Feed Pumps
   18. Gas Chlorination Feed Equipment
   19. Chemical Tanks
   20. Batch and Day Tank Mixers
   21. Sludge Pumps
   22. Clarifier Equipment
   23. Gravity Thickener Equipment
   24. Belt Filter Press Equipment
   25. Belt Conveyors
   26. Process Compressed Air System
   27. Rotary Blower
   28. Filter Underdrain and Air Distribution System
   29. Media Systems
   30. Fiberglass Washwater Troughs
   31. Chlorine Scrubber System
   32. Laboratory Furniture and Equipment
   33. Hoisting Equipment

C. Operation and Maintenance Manuals: Furnish in accordance with Specifications operation and maintenance manuals for each following item of equipment:
   1. Wedge Wire Intake Screens and Air Burst System
   2. Slide Gates
   3. Horizontal Mounted End Suction Centrifugal Pumps
   4. Vertical Turbine Pumps
   5. Chemical Transfer Pumps
   6. Sample Pumps
   7. Non-clog Centrifugal Pumps
   8. Progressive Cavity Pumps
   9. Sludge Collection Equipment

10. Fiberglass Weir Plates, Troughs, Stop Plates and Guides
11. Flocculation Equipment
12. Clarification Equipment
13. Plate Settlers
14. Rapid Mixing Equipment
15. Volumetric Chemical Feed Equipment
16. Liquid Polymer Feed Equipment
17. Chemical Feed Pumps
18. Gas Chlorination Feed Equipment
19. Chemical Tanks
20. Batch and Day Tank Mixers
21. Sludge Pumps
22. Clarifier Equipment
23. Gravity Thickener Equipment
24. Belt Filter Press Equipment
25. Belt Conveyors
26. Process Compressed Air System
27. Rotary Blower
28. Chlorine Scrubber System
29. Hoisting Equipment

D. Substitutions: When products or equipment of particular named manufacturers are specified or called for in Contract Documents, Bidders who contemplate substitution of other equipment or products must comply with requirements of Specifications regarding such substitutions. No consideration will be given to substitutions offered after opening of bids. Proposed items being substituted, manufacturer, and prices of specified and substituted items to be listed at proper place in proposal.

1.04 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Construction requirements of State, County, or other political subdivision specifications exceeding requirements of codes, standards, and approving bodies referenced herein to be met and complied with.
   1. Both Underwriters' Laboratories (UL) Listings and Approvals and National Electrical Manufacturers' Associations (NEMA) stamps or seals are to be evidenced where applicable to electrical apparatus forming parts of "mechanical" equipment.
   2. All electrical control panels furnished as part of the mechanical equipment are to be listed and labeled assemblies of a nationally recognized testing laboratory as outlined in the National Electric Code 90-7.

B. Certificates and Permits: Upon completion of work, and prior to final payment, furnish to Engineer formal certification of final inspections from authorities having jurisdiction and secure required permits, if any, from same. Additionally, prepare detailed diagrams and drawings which may be required by those authorities having jurisdiction.

C. Qualification of Manufacturer: Equipment to be furnished under this Contract to be essentially standard products of a manufacturer that has been regularly engaged in successful production of high quality equipment of this type for at least 10 years, and has supplied such equipment for at least 5 years of 10-year period and has at least five installations in successful operation for at least five years.

D. Shop Testing: Shop test all equipment specified under Division 11 - Equipment, in accordance with special requirements of each section within this Division.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: In addition to requirements for materials handling and storage as stated in Specifications, comply with following:
   1. 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.
   2. Store materials, equipment and machinery, both on and off site, in accordance with manufacturer's written instructions. Additionally, provide manufacturer's certificates of proper materials, equipment or machinery storage for following listed items. Prior to issuance of such certificates, a manufacturer's representative must visit site of storage and examine materials, equipment or machinery in actual storage conditions.
   3. When transporting materials, equipment and machinery both on site and from Contractor's storage to site, do so in accordance with recommendations of respective manufacturers of each.

1.06 JOB CONDITIONS

A. Electrical Interface:
   1. Install or mount, as work of Division 11 - Equipment, such electrical components or apparatus as provided by Product manufacturer's specified under various Sections of Division 11, unless specified otherwise to be installed under Division 16.
   2. Perform power wiring, including final connections of such to electrical components or apparatus of Products specified as work of Division 16.
   3. Motor starters required for equipment under this Division of Specifications will be provided under Division 16, except motor starters specified with equipment in this Division of Specifications.

B. Field and Shop Coat Compatibility: To ensure satisfactory paint and coating performance, it is a Contract requirement that products applied in shop and field be mutually compatible.
   1. Require fabricators and equipment manufacturers to apply shop coats that are specified in Section 09900.
   2. Above requirement does not apply to full factory-finished items, that is, items having both primer and final finish coatings, except as specified in Section 09900.

PART 2 PRODUCTS

2.01 MATERIALS

A. Shop Paint:
   1. For primer coat, use only those primers that are compatible with field coats. Primers and field coats are specified in Section 09900.

B. Motors:
   1. Provide motors of sufficient capacity to operate given equipment under all conditions of operation without loading beyond nameplate current or power.
   2. In no case are motors offered to be less than horsepower specified except when it can be demonstrated that because efficiency of driven equipment is greater than that specified, a lesser horsepower will suffice.
   3. Provide motors of drip proof, ball bearing type unless otherwise specified.
   4. Design motors to operate in an ambient temperature of 40 degrees C in continuous operation with a service factor of 1.15, unless noted otherwise for a piece of equipment.
   5. Explosion proof motors to comply with requirements of Class I, Division I, Group D, Hazardous Locations, as defined by National Electrical Code and be suitable for operating environment.
   6. All motors to comply with Standards of IEEE and NEMA in all respects except where requirements exceed these Standards.
   7. Provide vertical motors with thrust bearings adequate for axial loading to which they can be subjected in operation.
   8. Bearings for motors one-half horsepower and larger rated for 20-year life under AFBMA Standards.
   9. Design controls to operate on 120 volt, single phase, 60 Hertz current unless otherwise specified.

C. Electric Panels: Provide control panels listed and labeled by nationally recognized testing laboratory.

D. Lubrication: Provide means of lubrication for bearings and other metallic parts in sliding contact. Use alemite industrial type fittings except where specified otherwise in Division 11.
   1. Locate lubrication points on equipment readily accessible without necessity of removing covers, plates, housings or guards, or without creating safety hazards at installed equipment elevations.
   2. Exhaust pressure lubricated units to atmosphere to prevent excessive greasing.
   3. Provide two grease guns with appropriate fittings and one sealed 25- pound container of each type of lubricating grease required to service equipment.
   4. Provide lubricating oil for all equipment fitted for oil lubrication.
   5. Lubricate equipment prior to start-up.

E. Equipment Anchors: Provide anchors for equipment requiring such. Size anchors for embedding in concrete and sleeve anchors as recommended by equipment

manufacturers. When recommendations are not provided, size anchors in largest diameter that will pass through bolt holes in equipment bases. Anchor lengths set by manufacturer, except where lengths are set on Drawings.

1. Stainless Steel Anchor Bolts: ASTM A320 Grade B8, AISC Type 304.
2. Expansion Anchors: Conforming to Fed. Spec. FF-S-325, Group II, Type 4, Class 1 Stainless Steel; such as Hilti Kwik-Bolt, Phillips Red Head Wedge-Anchor and Molly Parabolt.
3. Adhesive Anchors: As specified in Section 05500, "Metal Fabrications."

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment with skilled mechanical erection labor in accordance with manufacturer's instructions.

B. Installed equipment to be inspected, adjusted, approved and certified satisfactory by manufacturer.

C. Have equipment manufacturer provide a factory-trained engineer for seeing that equipment is properly installed, for supervising startup of equipment and instructing operating personnel. For a minimum of [8 hours] per day for number of working days specified for each following item manufacturer's engineer will be available on site. List indicates minimum number of days services of factory-trained service engineers for specific equipment are required, but does not relieve Contractor of providing sufficient service to place above equipment in satisfactory operation, as determined by Engineer. Whenever deemed necessary by Engineer, at no additional cost to Owner, services of a factory-trained representative will be furnished for equipment not included in schedule.

1. Wedge Wire Intake Screens and Air Burst System - 1Day
2. Horizontal Mounted End Suction Centrifugal Pumps - 1 Day
3. Vertical Turbine Pumps - 8 Days
4. Chemical Transfer Pumps - 1 Day
5. Non-clog Centrifugal Pumps - 1 Day
6. Progressive Cavity Pumps - 1 Day
7. Sludge Collection Equipment - 4 Days
8. Fiberglass Weir Plates, Troughs, Stop Plates and Guides - 1 Day
9. Flocculator Equipment - 5 Days
10. Clarification Equipment - 7 Days
11. Rapid Mixing Equipment - 3 Days
12. Volumetric Chemical Feed Equipment - 5 Days
13. Liquid Polymer Feed Equipment - 3 Days
14. Chemical Feed Pumps - 8 Days
15. Gas Chlorination Feed Equipment - 3 Days
16. Sludge Pumps - 1 Day
17. Clarifier Equipment - 1 Day
18. Gravity Thickener Equipment - 1 Day

19. Belt Filter Press Equipment - 2 Days
20. Belt Conveyors - 1 Day
21. Rotary Blower - 1 Day
22. Filter Underdrain and Air Distribution System - 5 Days
23. Media Systems - Continuous during installation
24. Fiberglass Washwater Troughs - 2 Days
25. Chlorine Scrubber System - 1 Day
26. Chlorine Scrubber System - 7 Days
27. Laboratory Furniture and Equipment - 2 Days
28. Hoisting Equipment - 2 Days

D. Furnish Engineer with manufacturer's certificates regarding equipment installation prior to initial operation and mechanical performance tests.

E. Shop Painting:
   1. Prior to painting, remove all rust, dust and scale as well as other foreign substances on ferrous metal surfaces to be prime painted in shop, by sand-blasting or pickling in accordance with Section 09900.
   2. Ferrous metal surfaces thus cleaned to be prime painted within 24 hours after cleaning to prevent new rusting.
   3. All ferrous metal surfaces of equipment, apparatus, and devices to receive a shop coat of primer (except acceptable factory finished surfaces) unless otherwise specified or required by Engineer.
   4. Painting:
      a. Apply shop paint in accordance with SSPC-PA-1.
      b. Minimum dry mil thickness as specified in Paint Schedule in Section 09900.
      c. Prime coating compatible with field paint.

F. Field Painting: As specified previously in Painting: Section 09900.

G. Concrete Pads and Grout: Install all equipment on concrete pads. Unless shown differently, extend pads a minimum of 6 inches above concrete floor, 2 inches beyond edge of equipment, and provide a 1 inch chamfer on all exposed edges. Place a minimum of 1-1/2 inches of non-shrink, non-metallic grout between concrete pad and baseplate on all equipment requiring leveling.

H. Accessories: Installation of all small piping and valves required to make a complete and satisfactory installation is considered incidental to Contract and no additional payment will be made to supply and install accessories.

I. Spare Parts: Supply a complete set of spare parts for all equipment. A detailed list of spare parts are covered under sections in Division 11 - Equipment.

3.02 FIELD QUALITY CONTROL

A. Upon completion of structural work as well as installation and adjustment of equipment in a manner satisfactory to Engineer, place equipment in operation using own forces, including such equipment and other experts as may be necessary.

B. Test all equipment in accordance with requirements of Section 01669 and special requirements listed throughout Sections in Division 11 - Equipment.

END OF SECTION

SECTION 11204

WEDGEWIRE INTAKE SCREEN EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Stainless steel wedge wire intake screens, air backwash system and related equipment. Two (2) screens shall be provided for Phase 1 and one (1) screen shall be provided for Phase 2.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Products: Section 01600.
   3. Paints and Coatings: Section 09900.
   4. Basic Equipment Materials and Methods: Section 11005.

1.02 REFERENCES

A. American Society For Testing and Materials:
   1. ASTM A167, Stainless and Heat Resisting Chromium Nickel Steel Plate, Sheet and Strip.

1.03 SYSTEM DESCRIPTION

A. General: Provide all screens, and accessories of design and construction as fabricated, assembled, and tested by one manufacturer.

B. System Design: Provide two (2) screens for Phase 1 and one (1) screen for Phase 2 for filtering raw water complete with all accessories.
   1. Screens:
      a. 42 inch diameter, tee mounted, vertical, wedge wire screens constructed of 304 stainless steel, as shown on drawings.
      b. 0.125 inch slot openings.
      c. 35 foot water design collapse strength.
      d. Maximum 0.5 fps design through flow velocity at maximum design flow per screen (15.0 mgd). Add length to screens to maintain maximum design through flow velocity as necessary.
      e. Mounted to intake piping with a 30 inch flanged joint.
      f. Provide two (2) 3/4-inch non-retractable type chemical connections at each screen.
      g. Air Backwash System

C. Corrosion prevention and finish painting to be applied to all corrosive surfaces in accordance with Section 09900. General requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement

considered necessary for any individual item specified under respective item to be provided by manufacturer.

1. Fastening and Fittings. All screws, bolts, nuts, pins, studs, rings, washers, and other similar fittings of corrosion resisting material or treated in an approved manner to render them resistant to corrosion. Galvanizing, sheradizing, zinc cadmium and copper plating when properly done and of a sufficiently heavy coat are approved corrosion resisting treatments. Other corrosion resisting treatments may be used if approved by Owner.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings for screens and all related equipment in accordance with Section 01300 and Section 11005, demonstrating compliance with specifications, including:
   1. Manufacturer's literature, illustrations, specifications and engineering data defining materials of construction, dimensions, weights, and maximum flow velocities.
   2. Parts list including a list of recommended spare parts and maintenance tools.

B. Quality Assurance/Control Submittals:
   1. Provide statement indicating that screen manufacturer has reviewed flow conditions on Drawings along with indicated normal and low water levels and installation method shown and that manufacturer's screen units will operate without problems. If manufacturer does not believe units will operate properly, so state and list what modifications must be made before he can guarantee correct performance.

C. Written Installation, Operation, and Maintenance Instructions

1.05 QUALITY ASSURANCE

A. General Requirements: Comply with all provisions of Section 11005 - General Equipment Requirements.

B. Basis of Design: Specifications are based on Johnson Water Intake Screen equipment. Bear all costs resulting from changes to structure, piping, etc., required for approved equal equipment, in accordance with Contract Documents. Submit drawings to Engineer for approval, showing changes in equipment, piping, structure and electrical work.

C. Responsibility: To ensure that all equipment required for installation of screens is properly coordinated and will function in accordance with intent of these Specifications, obtain all equipment specified under this Section from a single supplier. Supplier vested with responsibility for proper function of all equipment, regardless of manufacturer, as an integrated and coordinated system. Intent of this paragraph is to establish unit responsibility for all equipment by one supplier. Use of word "responsibility" relating to equipment supplier not intended to relieve

Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

1.06 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Deliver, store and handle equipment in accordance with these Specifications and manufacturer's instructions.

B. See Section 01600 for general handling, storage and protection requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Johnson Screens, Inc. (Weatherford)
   2. Tate-Andale
   3. Cook Legacy Coating Systems

2.02 HYDROBURST AIR BACKWASH SYSTEM

A. General
   1. The intake screen supplier shall provide, as part of the overall intake screen system, an air backwash system designed to remove debris from the screen surface by delivering a suitable volume of compressed air to the inside of the screen body. The exiting air shall scour the screen surface to maintain adequate design flow and through slot velocity characteristics.
   2. The Hydroburst air backwash system shall consist of an integrated system of compressor, receiver tank, valves and control panel.
      a. The dual compressors shall be a reciprocating type and shall be sized to recover from each backwash in 30 minutes.
      b. The receiver shall be a 660 gallon receiver, ASME coded for 200 psig, sized for the system piping and to displace THREE SCREEN VOLUMES of air AT THE SCREEN during a backwash to provide suitable debris removal and cleaning. Two of the three volumes shall be delivered n the first second of the backwash cycle.
      c. The receiver shall be a equipped with a 4-inch isolated pressure gauge, safety valve and automatic drain valve.
      d. The system shall include one bubble type butterfly valve rated at 200 psi with standard ANSI class 125/150 flanges. There shall be one valve per screen and shall be sized to match the tank flange and the backwash piping.

B. Automatic Operation
   1. The above butterfly valves shall be provided with a pneumatic actuator with direct mounted solenoid valves, position actuator and position switches.

2. The system shall include a suitably sized air receiver interconnected and charged by the main receiver to allow valve operation. The system shall be interconnected to all other pneumatic valves located at the Raw Water Pump Station.
3. A NEMA 4 control panel shall be included that will contain as a minimum, the motor starter for the compressor, control power transformer and a PLC or relay logic to perform the specified control functions.
4. The controls shall allow timed automatic or manual initiated air cleaning cycles. A cycle consists of cleaning all intake system screens.
5. The control system included shall allow full week duration of programmed Hydroburst cycles.

C. Interconnecting piping between the intake screen assembly and the Hydroburst System is by others. All interconnecting wiring to automated valving and power connections is done by others.

D. Include in the intake screen submittals shall be all associated Hydroburst equipment catalog information, system sizing criteria and drawings. All dimensional and operational information will be provided. All interconnecting wiring and piping information will be included.

2.03 MATERIALS

A. General
1. 304 Stainless Steel: Conforming to ASTM A167.
2. Anchor Bolts: Type 304 stainless steel of ample size and strength for intended purpose. Furnish anchor bolts with equipment and set in accordance with manufacturer's instructions. Dissimilar metals to be protected against corrosion due to galvanic action.
3. All equipment designed for continuous, 24 hour operation. All parts of mechanism amply proportioned for any and all stresses occurring during fabrication, erection, and operation.

2.04 FINISHES

A. Painting: Shop sandblast all ferrous metal surfaces. Shop prime and finish coat in accordance with Section 09900.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine all equipment prior to erection. Repair or replace damaged items as directed by Engineer, at no additional cost to Owner. Have only factory-trained manufacturer's representative perform repair work.

3.02 INSTALLATION

A. General: Install screens in conformance with provisions of Section 11005 of Specifications and as shown on Drawings.
   1. Install each screen in accordance with manufacturer's literature and recommendations under supervision of a factory-trained manufacturer's representative.
   2. Set unit level and true, to proper elevation.

3.03 FIELD QUALITY CONTROL

A. Site Tests:
   1. Manufacturer's representative to check and verify that installation of equipment is in accordance with Drawings and manufacturer's installation instructions prior to placing equipment in service.

END OF SECTION

SECTION 11212

HORIZONTAL MOUNTED END SUCTION CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision for horizontal mounted close coupled end suction centrifugal pumps for chlorine injector booster pumps, clarified wastewater pumps, and thickener supernatant as indicated on Drawings.

B. Related Sections:
1. Submittals: Section 01300.
2. Testing: Section 01650.
3. Grouts: Section 03600.
4. Paints and Coatings: Section 09900.
5. Basic Equipment Materials and Methods: Section 11005.
6. Division 16: Electrical.

1.02 REFERENCES

A. Hydraulic Institute, Latest Edition.

B. American Society for Testing Materials:
1. ASTM A48, Specifications for Gray Iron Castings.

1.03 DESIGN CRITERIA

A. Pumps installed in plant service pump room and analyzer room as shown on Drawings.

B. Pumps and motors designed to operate under following conditions:

Description	Units	Chlorine Injector Pump Nos. 1 & 2	Clarified Wastewater Pump Nos. 1 & 2	Thickener Supernatant Pump Nos. 1, 2, & 3
1. General: Suction inlet diameter	inches	2	2	2
discharge outlet diameter	inches	1½	1½	1½
Connections		NPT Threaded	125 lb Flanges	125 lb Flanges
Liquid to be pumped		Plant Effluent Water	Clarified Wastewater Decant	Thickener Supernatant Decant

Description	Units	Chlorine Injector Pump Nos. 1 & 2	Clarified Wastewater Pump Nos. 1 & 2	Thickener Supernatant Pump Nos. 1, 2, & 3
2. Design Points: Design Point No. 1 (Primary) Capacity	gpm	150	2,820	855
TDH	feet	138	48	41
Minimum Efficiency	%	68	72.9	77.9
Design Point No. 2 Capacity	gpm	200		
TDH	feet	100		
Minimum Efficiency	%	68		
Design Point No. 3 Capacity	gpm	100		
TDH	feet	162		
Minimum Efficiency	%	62.5		
Maximum Shut-Off Head	feet	172		
3. Motor Requirements Horsepower	hp	10	50	10
Voltage	volts	460	460	460
Nominal Speed	rpm	3550	1800	1800
Enclosure	--	TEFC	TEFC	TEFC
Service Factor	---	1.15	1.15	1.15
Design		Premium Efficiency	Premium Efficiency See Note 1	Premium Efficiency See Note 1
4. Minimum Suction Head	feet	95	12	12

C. Pumps constructed and assembled in accordance with Hydraulic Institute Standards.

1.04 SUBMITTALS

A. Submit shop drawings for pumping equipment in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications, including:

1. Manufacturer's literature, illustrations, specifications and engineering data defining materials of construction, dimensions, weights, and pump motor performance.
2. Parts list including a list of recommended spare parts and maintenance tools.
3. Location of nearest permanent service headquarters.
4. Head vs. capacity, efficiency, brake horsepower and NPSH curves.
5. Written installation, operation, and maintenance instructions.

1.05 QUALITY ASSURANCE

A. General: Comply with all provisions of Section 11005 - General Equipment Requirements.

B. Basis of Design: Drawing layout and Specifications are based on Goulds centrifugal pumps. Any costs resulting from changes to structure, piping, electrical work, plumbing work, etc., required for another pump manufacturer's pumps, borne by Contractor. Submit drawings to Engineer for approval, showing changes in equipment, piping, structure, electrical work, and plumbing work.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle pumps and motors in accordance with these Specifications and manufacturer's recommendations.

1.07 JOB CONDITIONS

A. Wiring: Wiring to and from starters, switches, relays, and contacts to be performed under Division 16 - Electrical.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
1. Goulds Pumps, Inc.
2. Peerless
3. Flowserve
4. Paco

2.02 MATERIALS

A. General.
1. Pump and motors close coupled with impeller mounted on extended motor shaft. No flexible couplings or bed plate required.
2. All bolts and nuts to have hexagonal heads.
3. Furnish Type 304 stainless steel anchor bolts. Length and diameter of anchor bolts set by manufacturer. Leg of anchor bolts to extend at least beneath second row of reinforcing in reinforced concrete pump base.

4. Set each anchor bolt in a polyethylene anchor bolt sleeve.
5. Furnish each pump with a stainless steel data plate securely attached to unit. Data plates to contain manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.

B. Pumps
1. Casing: ASTM A48, Class 30 cast iron capable of hydrostatic test at 150% of maximum discharge pressure. All mating parts to have a register fit to ensure alignment.
2. Impeller: Enclosed, single piece bronze casting impeller completely machined on all outside surfaces and statically balanced at time of pump assembly. Impeller keyed to shaft and securely fastened with a vibration resistant lock screw and washer. Impeller to not contact suction or hub wear ring under any load condition.
3. Stuffing Box: Stuffing box suitable for and equipped with a mechanical seal.
4. Motor: U.S. Electrical Motors or General Electric Company, as shown on Design Criteria. Non-overloading, exclusive of service factor, at any point on pump head-capacity curve. Motor supply power 460 volt, 60 hertz, 3 phase. Inverter duty motor as indicated in Design Criteria.
5. Bearings and Housing: Bearings selected to withstand thrust loads and have a minimum B-10 life of 20,000 hours. Pump and motor connected by ASTM A48, Class 30 cast iron bracket incorporating full isolating shield with dual fingers to prevent moisture entering front bearing.
6. Shafts: High strength steel. Maximum allowable shaft end play of 0.002 inch.
7. Spare Parts:
   a. One mechanical seal for each pump.
   b. One set of bearings for each pump and motor.
   c. One set of impeller and casing wear rings for each pump.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pump in accordance with manufacturer's literature.

B. Set unit level and true, shim grout plate to proper elevation and grout in place using nonshrink, nonmetallic grout as specified in Section 03600.

C. Painting
1. Field paint or touch-up factory coatings for each pump, motor and baseplate in accordance with Section 09900.

3.02 FIELD QUALITY CONTROL

A. Conduct testing in accordance with Section 01650 and details provided hereinafter.

B. Preliminary Testing.
   1. Provide services of a manufacturer's representative for a minimum of 8 hours for testing.
   2. Run pumps to verify the head, capacity, efficiency and horsepower of the pumps at shutoff, and the three equally spaced design points.
      a. Flow. Measure flow from meter or by other reliable means as provided by Contractor.
      b. Head. Measure pressure using calibrated test gauges (suction and discharge) capable of accurate readings to 0.25 psi ±.
      c. Amperage and Voltage. Provide calibrated amperage and volt meter to measure power input to the pumping units.
      d. Power Factor. Use certified power factor of the motor as provided by the manufacturer.
      e. Acceptable Fluctuations in Test Readings As Long as Motor Does Not Overload.
         1) Differential pressure across pump (ft): +5% x ft
         2) Flow (Q): +10% x Q
         3) Power input to motor (bhp): +5% x motor hp
   3. Vibration. Measure vibration on bearing housing to meet maximum vibration standards allowed in the American National Standard for Centrifugal and Vertical Pumps of the Hydraulics Institute Standards. The manufacturer shall provide the calibrated instrument along with a Certification of Calibration.
   4. Cavitation. Check for cavitation noise by listening for the gas impinging on the impeller and volute. Any indication of cavitation is unacceptable.

C. Final Testing. The services of the manufacturer's representative will not be required, but he shall be alerted to be on call if his services are required. Run the test in conjunction with the final Mechanical Performance Test described in Section 01650. Observe the units for the following:
   1. Overheating or Overloading of the Motor.
   2. Cavitation Noise.
   3. Vibration.
   4. Lubrication.

D. Manufacturer's Service. The cost for providing a manufacturer's service representative for start-up and testing shall be borne by the Contractor and shall be included in the Contract bid price. No time or trip limitations shall be placed on these services.

E. Correct all deficiencies to satisfaction of Engineer.

3.03 DEMONSTRATION

A. Startup and test system in accordance with Section 01650.

B. Have factory-trained manufacturer's representative instruct plant personnel on repair and maintenance of pumping unit for time period indicated in Section 11005.

3.04 PROTECTION

A. After installation, protect drive units from moisture and temperature in accordance with Section 01600. Provide heated covers and enclosures where necessary.

END OF SECTION

SECTION 11214

VERTICAL TURBINE PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for furnishing, installing, and testing all vertical turbine pumps and motors on this Project including four (4) raw water, four (4) high service, and two (2) washwater pumps and motors for Phase 1 and one (1) raw water and one (1) high service pump and motor for Phase 2. Two (2) raw water/high service motors must be suitable for use with variable frequency drives (VFD), as shown on the Drawings and as specified herein.

B. Related Sections:
   1. Testing: Section 01650.
   2. Grouts: Section 03600.
   3. Paints and Coatings: Section 09900.
   4. Basic Equipment Materials and Methods: Section 11005.
   5. Basic Measurement and Control Instrumentation Materials & Methods: Section 13410.

1.02 REFERENCES

A. American National Standards Institute:
   1. ANSI C50, Rotating Electrical Machinery.
   2. ANSI S1.1, Acoustical Terminology.
   3. ANSI S1.2, Physical Measurement of Sound.

B. American Society for Testing and Materials:
   1. ASTM A48, Specifications for Gray Iron Castings.

C. Hydraulic Institute, Latest Edition.

D. Institute of Electrical and Electronic Engineers, IEEE.

E. National Electrical Manufacturing Association, NEMA.

F. Steel Structures Painting Council
   1. Surface Preparation Specifications:
      a. SSPC-SP-6, Steel Structures Painting Council Surface Preparation.
      b. SSPC-SP-10, Near White Blast Cleaning.

G. Anti-Friction Bearing Manufacturers Association, AFBMA.

1.03 QUALITY ASSURANCE

A. Supplier Requirements: To ensure that all the equipment required for the installation of the pumps and motors is properly coordinated and will function in accordance with the intent of these Specifications, all of the equipment specified under this Section will be from a single supplier in whom the responsibility for the proper function of all the equipment, regardless of manufacturer, as an integrated and coordinated system is vested. The intent of this paragraph is to establish unit responsibility for all equipment by one supplier. Use of the word "responsibility" relating to the pumping equipment supplier is in no way intended to relieve the Contractor's ultimate responsibility for equipment, coordination, installation, operation, and guarantee.

B. Shop Testing:
   1. Pumps:
      a. Test each pump at the manufacturer's shop with the job motor or an approved shop drive.
      b. Each pump test shall include three equally spaced points in addition to the shutoff, primary design point, and two secondary design points.
      c. No minus tolerance or margin with respect to capacity, total head will be allowed. Pump performance shall be within the following tolerances as long as the motor does not exceed the nominal motor rating by 5 percent and the tolerances are compatible with the associated pump.
         1) At Specified Head: Plus 10 percent of specified capacity.
         2) At Specified Capacity: Plus 5 percent of specified head.
      d. Pump test efficiency shall equal or exceed specified value.
      e. Conduct shop tests in accordance with hydraulic institute standards except as modified herein.
      f. Submit certified test data for approval in accordance with these Specifications.
   2. Motors:
      a. Test each motor at the motor manufacturer's shop.
      b. Perform tests on the motors that are specified herein below.
         1) High Potential (Dielectric) Test on Armature.
         2) Insulation Resistance.
         3) No Load Current at Rated Voltage.
         4) Efficiency and Power Factor Calculated at 100 percent of full load at full load speed.
         5) Schedule of Losses as specified in ANSI C50.
         6) Overspeed Test.
         7) Measurement of Air Gap by Gauge.
         8) Balance.
         9) Bearing Inspection.
      c. Submit certified test data for approval in accordance with these Specifications.
   3. The Owner reserves the right to witness the factory test. Manufacturers shall provide Owner two weeks notification prior to test.

C. Manufacturer's Representatives. Provide factory-trained manufacturer's representative to supervise installation and field testing, and instruct Owner's personnel in the operation and maintenance of all equipment for the minimum number of days specified in Section 11005.

1.04 SUBMITTALS

A. Bid Statements:
   1. A statement shall be provided with the bid indicating that the pump manufacturer has reviewed the pump suction conditions on the Drawings along with the indicated normal and low water levels and that the manufacturer's pumping units will operate without submergence, NPSH, entrance and other hydraulically related problems. If the manufacturer does not believe the units will operate properly, he shall state so and list what modifications must be made before he can guarantee correct performance. Also, pump manufacturer to supply the recommended size, location and dimensions of the vortex suppression facilities and baffle walls if required for proper system operation.
   2. The pump manufacturer shall submit a bid statement stating that he has reviewed the specification for the variable frequency drives and that his pumping equipment will function properly with those units equipped with variable frequency drives. If the pumping equipment will not function properly with the variable frequency drives, the pump manufacturer shall state what modifications must be made to the variable frequency drives so that the pumps will function properly.
   3. Manufacturer shall review installation details for proposed pumping units and confirm the suitability of details for the pump installation. If details are not satisfactory, the manufacturer shall provide statement as to modification required and contractor shall include costs for this work in his bid.
   4. Above submittals may be made to the office of the Engineer prior to the receipt of Bids.

B. Submit a frequency interaction analysis between the mechanical equipment and the supporting building structure (support slabs, support beams, individual support footings as applicable) for the raw water and high service pump stations. Analyze the full range of the mechanical equipment speed and document that vibrations caused by these speeds are not within 30 percent of the significant frequency modes of the structure (significant frequency mode is a mode with high mass participation factor and a high amplitude at the location of the mechanical equipment).
   1. If necessary suggest modifications to the building structure supporting elements to modify its natural frequency and avoid resonance with the mechanical equipment. (adding support walls, support columns, support beams, or modifying the operating regime of the mechanical equipment to avoid speeds causing resonation with the building structural elements). The analysis shall be 2 dimensional or 3 dimensional using finite element method by a documented software. All the analysis input values, geometry, material properties and the results and recommendations should be presented in "layman" terms. The analysis shall be signed and sealed by a professional engineer.

C. Submit in accordance with these Specifications, Shop Drawings for the pumping equipment demonstrating compliance with these Specifications including:
   1. Manufacturer's literature, illustrations, specifications and engineering data defining materials of construction can dimensions, anchoring methods, and operating weights; pump and motor dimensions and weights, and pump motor performance.
   2. Parts list including a list of recommended spare parts and maintenance tools.
   3. Shop drawings, motor data sheets, and certified test data curves. Curves for the pumps, in particular, shall include the number of pump stages, the head/discharge characteristics of the pump, the horsepower requirements, full load speed, the bowl efficiency, NPSH, submergence requirements and motor horsepower. The curves shall cover the range of operation of the pump from shutoff to 125 percent of capacity at peak pump efficiency or Design Point No. 3, whichever is greater.

1.05 DESIGN CRITERIA

A. General. All pumps shall be supplied by one manufacturer and all motors shall be supplied by one manufacturer. All pumps, motors, and accessories shall be furnished by one vendor. All pumps and motors shall be of standard design and construction as fabricated, assembled, and tested by the manufacturer.

B. System Design.
   1. High Service vertical turbine pumps shall be provided for the applications of pumping finished potable water, some with use of VFD drives as described herein and in Division 16.
   2. Raw water vertical turbine pumps shall be provided for applications of pumping raw water, some with use of VFD drives as described herein and in Division 16.

C. Pumps.
   1. The thrust of each pump at any point on it's design curve shall not exceed the standard thrust rating of the motor.
   2. All pumping units shall be designed to withstand reversal up to 150 percent of full speed without damage to or failure of any part of the pumping unit.
   3. Raw Water and Finished water pumps to be water lubricated open lineshaft pumps. Raw water pumps to be provided with splash lubrication of all bearing points above the low water sump elevation.

D. Motors.
   1. Motors in all cases shall meet as minimum requirements the published standards, rules, and regulations of NEMA, ANSI, and the IEEE as to application, manufacture and tests.
   2. The motors shall be vertical, hollow or solid shaft, except for motors larger than 500 horsepower which shall be solid shaft, squirrel cage induction, ball bearing motors. All motors shall be furnished with a non-reverse ratchet and a coupling in the pump base to disconnect the motor for lifting. Motors shall be especially suitable both electrically and mechanically to drive the pumps specified herein-below. The speed, horsepower, torque, base, bearing, and shaft shall be

closely coordinated with pump requirements as to provide a satisfactory, efficient, drive without overloading, overheating, or abnormal vibration.

3. All motors shall be rated for the type of starting as listed in Table 1. The motors shall be NEMA Design B, normal torque, normal starting current. The motors shall not exceed 80 degrees C. by resistance for the starter windings and 70 degrees C. by thermometer, above an ambient of 40 degrees C. The resistance method shall be used to determine the winding temperature. All motors to be premium efficiency.
4. Furnish motors for use with VFD's which are specifically designed for VFD service, respectively, and have a 1.15 service factor while operating on VFD's. VFD motors shall be rated for inverter duty service.

E. The pumps and motors shall be designed to operate under the conditions as listed in Table 1.

TABLE 1
Vertical Turbine Pumps

Description		Raw Water				High Service				Washwater
		Phase 1			Phase 2	Phase 1			Phase 2	
	Unit	Nos. 1&2	No.3	No. 4	No. 5	Nos. 1&2	No.3	No. 4	No. 5	Nos. 1&2
A. General										
Operating Conditions	—	VFD	Const. Speed	Const. Speed	Const. Speed	VFD	Const. Speed	Const. Speed	Const. Speed	Const. Speed
Type	—	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine	Vertical Turbine
Floor Elevation	feet	502.00	502.00	502.00	502.00	740.00	740.00	740.00	740.00	740.00
Centerline elevation of discharge	feet	± 504.25	± 504.25	± 504.25	± 504.25	745.50	742.50	742.50	742.50	742.50
Bottom elevation of can	feet	—	—	—	—	—	—	—	—	—
Centerline Elevation of suction header	feet	—	—	—	—	716.25	716.25	716.25	716.25	716.25
Low water level	feet	455.13	455.13	455.13	455.13	727.00	727.00	727.00	727.00	727.00
Normal water level	feet	457.13	457.13	457.13	457.13	—	—	—	—	—
Min. Column Diameter	inches	16	14	14	12	16	12	12	12	16
Discharge outlet diameter	inches	20	16	16	16	20	12	12	12	20
Minimum flange classification	lb/in^2	150	150	150	150	150	150	150	150	150
Minimum shaft diameter	inches	2.6875	2.25	2.25	2.4375	2.6875	2.25	2.25	2.4375	2.25
Maximum length of discharge column assembly between flanges spacing of shaft guides, and line shaft	feet	5	5	5	5	5	5	5	5	5

Description	Unit	Raw Water				High Service				Washwater
		Phase 1			Phase 2	Phase 1			Phase 2	
		Nos. 1&2	No.3	No. 4	No. 5	Nos. 1&2	No.3	No. 4	No. 5	Nos. 1&2
Minimum material type of line shaft	—	416 S.S.	416 S.S.	416 S.S.	416 S.S.	416 S.S.	416 S.S.	416 S.S.	416 S.S.	416 S.S.
B. Motor										
Motor rating (see Note A)	hp	700	500	500	500	700	500	500	500	150
Approximate speed at no load (see Note B)	rpm	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	900
Minimum full load power factor	%									85
Service factor, continuous duty	---	1.15	1.15	1.15	1.00	1.15	1.15	1.15	1.00	1.15
Voltage, 3 phase, 60 hertz	volts	4160	4160	4160	4160	4160	4160	4160	4160	4160
Minimum full load efficiency	%									
Type of Starting	---	VFD	RVSS	RVSS	RVSS	VFD	RVSS	RVSS	RVSS	RVSS
C. Design Points (at full speed)										
Design Point 1 (Primary)										
Capacity	gpm	6,944	4,900	4,900	4,200	6,944	4,900	4,900	4,200	8,780
Total dynamic head (see Note C)	feet	325	325	325	325	323	323	323	323	44.0
Bowl efficiency	%	85.2	83.75	83.75	72.68	85.2	83.75	83.75	72.68	84.1
Design Point 2										
Capacity	gpm	5,900	4,165	4,165	3,570	5,900	4,165	4,165	3,570	7,45
Total dynamic head (see Note C)	feet	330	377	377	542	330	377	377	542	47.5
Bowl efficiency	%	81	83	83	67.3	81	83	83	67.3	82.5
Design Point 3										
Capacity	gpm	7,985	5,635	5,635	4,830	7,985	5,635	5,635	4,830	10,100
Total dynamic head (see Note C)	feet	259	238	238	284	259	238	238	284	30
Bowl efficiency	%	82.5	80.5	80.5	78	82.5	80.5	80.5	78	72
D. Miscellaneous pump requirements										
Maximum dynamic head along curve	feet	571.2	532.7	532.7	455	571.2	532.7	532.7	455	94
Max. required net positive suction head at hereinabove specified design points	feet	24.91	18.49	18.49	30.82	24.91	18.49	18.49	30.82	16

NOTE A: VFD driven motors may not operate in the service factor at any point on the pump curve.

NOTE B: In order to obtain the best pump design, the rpm of any pumping unit may vary from what is specified, as long as the rpm is 1,800, 1,200 or 900. However, the Contractor shall incorporate any modifications into the design of the structure and base as required to accommodate a pump of lesser speed than that specified.

NOTE C: The total dynamic pumping head does not include losses in the pump and suction column which must be allowed for by the manufacturer. The efficiency of the pumping unit shall be as high as correct design and good engineering will permit.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle the pumps and motors in accordance with these Specifications and the manufacturer's recommendations.

1.07 JOB CONDITIONS

A. Wiring: Wiring to and from the starters, switches, relays, and contacts shall be furnished and installed under Division 16.

PART 2 PRODUCTS

2.01 MATERIALS

A. Pumps:
   1. General.
      a. Provide anchor bolts for all pumps.
      b. All nuts to have hexagonal heads.
      c. Type 304 stainless steel anchor bolts shall be furnished. The diameter of the anchor bolts as recommended by the pump manufacturer. The lengths shall be as shown on the Drawings. Furnish polyethylene anchor bolt sleeves.
      d. Furnish each pump with a stainless steel data plate securely attached to the unit. Data plates to contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating, and other pertinent data.
      e. Shop prime pumps in accordance with Section 09900 and as specified hereinbelow.
   2. Bases.
      a. Mount motors on a high grade cast iron or fabricated steel pump bases.
         1) Pumps shall have above or below the floor discharges as shown on drawings.
      b. Base top flange diameter shall be equal to the diameter of the motor base.
      c. Pump base bottom plate shall be square hexagonal or round. Pump bases to have critical dimensions at least equal to those shown on the Drawings.
         1) Thickness of the bottom plate to be determined by the manufacturer.
         2) Base plate to be strongly built and constructed to support the weight of the complete pumping unit plus maximum load during operation.
         3) Maximum deflection of the pump bottom plate over the floor opening shall not exceed 0.015 inch under full operating load, and the deflection shall be symmetrical in all directions to the pump centerline.

d. Machine each top surface of the pump discharge head to perfectly match the motor base. Machine the bottom surface of the pump base and the top surface of the base plate to a 250 RMS finish so that they match perfectly.
e. Design the discharge head to provide for easy disengaging of the pump line shaft from the motor shaft.
f. Accessories. Pump bases to include stuffing box complete with bronze bearings, bronze gland, packing, and water slinger. A coupling is to be located between the stuffing box and motor. Openings are to be provided in each side of the base to allow access for maintenance of the stuffing box, and assembly and disassembly of the coupling.
g. Each pump base shall have a threaded 3/4" drain opening located as shown on the Drawings.
h. Each pump base to have connection for air / vacuum valve.

3. Steel Grout Plate: Fabricate from high strength plate steel. Length and width of each mounting plate shall be as shown on the Drawings. Manufacturer to establish thickness of each plate. Machine the underside and topside of each plate to a 250 RMS finish to perfectly match the machined underside of the pump base respectively.
4. Anchor Bolts: Pump manufacturer to provide all anchor bolts. Anchor bolts to pass through the pump mounting plate and extend through the base slab as shown on the Drawings. Manufacturer to furnish setting instructions for the anchor bolts and prepare foundation detail indicating the size, length, and number of anchor bolts required for the installation. Furnish polyethylene anchor bolt sleeves.
5. Discharge Column Assembly: Column pipe to be constructed of steel and have the minimum size and weight per lineal foot as shown in the Design Criteria. Pipe to be furnished in interchangeable sections with flanged joints and not exceeding the maximum length shown in the Design Criteria. The flanges shall be accurately machined and faced after welding to assure perfect alignment. Flanges shall have rabbeted fits and O-ring grooves to insure alignment and seal. Flange thickness shall be as set by the manufacturer.
   a. Line shaft bearing shall be fluted cutless rubber or bronze, and shall be mounted in cast iron, welded steel or bronze bearing retainers. Bearings shall be provided at each flanged column connection.
   b. Bearing support spiders shall be provided at each bearing location. Spiders shall be welded to the column at each column flange for easy assembly and disassembly.
6. Line Shaft: The line shaft for each pump shall have a minimum diameter and maximum length of interchangeable sections as listed in the Design Criteria. Line shaft to be turned, ground, and polished precision shafting of ample size to operate the pump without distortion or vibration. Machine butting faces so they are square to the axis of the shaft.
   a. Line shaft ends to be joined by shaft couplings of the key and split ring type, the key and pin type, or screw type. Shafting 1-1/2" in diameter and smaller can utilize the screw type while all the shafts larger than 1½" in diameter shall be of the key and split ring type or the key and pin type. Couplings

shall be fabricated of No. 416 stainless steel. Locate couplings in areas of torsional stress.

7. Drive Shaft Coupling: Drive shaft coupling for solid shaft motors shall be a solid steel flanged adjustable type or steel threaded type permitting adjustment of the impellers in such a position as to give best performance to compensate for wear. Coupling for hollow shaft motors to be flanged type. Impeller adjustments for hollow shaft motors to be made by a nut at the top of the motor shaft.
8. Bowl Assembly: Pump bowls are to be enameled and made of close grained cast-iron, conforming to ASTM A48, Class 30, having a minimum tensile strength of 30,000 psi free from blow holes, sand holes, and all other faults; accurately machine fitted to close dimensions.
    a. Impeller shaft to be of stainless steel not less than 12% chrome. Support the impeller shaft by water-lubricated, fluted rubber and/or bronze bearings.
    b. Impeller to be bronze or nickel-aluminum bronze, enclosed or semi-enclosed, accurately machined and finished and perfectly balanced, both mechanically and hydraulically. Impellers to be securely fastened to the impeller shaft with upper and lower split rings, impeller key, and a split ring retainer (tapered bushing).
    c. Each bowl to have an impeller case hub seal ring to prevent slippage of water between bowl and impeller. Closed impellers shall also have a case eye seal ring.
    d. Impellers to be adjustable by means of a nut in the pump head.
9. Suction Manifolds. All pumps are to be furnished with pump suctions designed to permit distribution of the liquid to the impellers. Each pump shall be equipped with a bell type suction manifold to reduce losses.
10. Water Lubrication.
    a. High service pumps will be open lineshaft, water lubricated.
    b. Raw water pumps will be open lineshaft, water lubricated.
11. Shop Painting. The inside and outside of the discharge heads, columns and suction manifolds and the exterior of the bowl assemblies shall be sandblasted in accordance with SSPC-SP-10 (SSPC-SP-6 for cast iron). The inside surfaces shall then be coated with a 10 mil protective coating of Plasite No. 9133, Wisconsin Protective Coating Corporation, paint. The exterior surfaces of the column and bowl assembly shall be prepared and primed in accordance with submerged metal requirements of Section 09900. The exterior surface of discharge heads shall be painted in accordance with non-submerged metal requirements of Section 09900. Application to be in accordance with manufacturer's instructions.
12. Manufacturers:
    a. Floway.
    b. Peerless Pump Co.
    c. Flowserve.
    d. Goulds.

B. Motors:
   1. General
      a. Nameplates. Provide nameplate of stainless steel indicating all essential information including: type, frame, insulation, class, hp, full load current, rpm, centigrade degree rise, manufacturer's name and serial number, model, phase, voltages, locked rotor kva, code, bearing numbers, and lubrication including type, viscosity, frequency, etc.
      b. Motor Connection Diagram. Provide SS nameplate with motor connection diagram.
   2. Enclosure and Frame. Enclosure and frame shall be of cast iron or heavy fabricated steel, of such design and proportion as to hold all motor components in proper position. All motors shall be open, dripproof, fully guarded, self-ventilating.
   3. Rotors. Rotors shall be made from high grade steel laminations, adequately fastened together and to the shaft. Squirrel cage windings shall be either cast aluminum or bar type with brazed or welded end rings.
      a. Overspeed. The rotor shall be capable of operating at a minimum speed of 150% of rated speed in either direction of rotation and shall withstand the full run-away speed as designated by the pump manufacturer.
      b. The rotor shall be statically and dynamically balanced to provide a maximum total deflection, or amplitude of vibration of 0.001-inch, measured at any point on the motor frame or bearing brackets. Rotor cores shall be firmly pressed on to the shaft, and shaft shall be shouldered under the rotor core to prevent slippage.
   4. Windings. Windings shall be adequately insulated and braced for the voltages listed in Table 1. Motor insulation shall be Class F. Motors smaller than 200 Hp shall have random wound coils with a vacuum impregnated type insulation system. All stator insulating materials, slot wedges, phase pieces, leads, and lacings shall be nonhygrosopic. Wire shall be a premium enameled multiple build type. Stator shall receive extra dips and bakes of Bondite insulating varnish. Rotor and stator shall be coated with phenolic varnish for moisture protection. High service and raw water pump stators shall be provided with three pair 100 ohm platinum resistance temperature detectors (RTDs). The RTD's and accessories, installation, etc. shall be as specified for the RTDs for the motor bearings.
   5. Bearing. Bearings shall be selected to have AFBMA rated (minimum) life of 5* years when operated continuously at rated speed of motor, and at total load consisting of the weight of the motor rotor, plus combined dead weight and hydraulic thrust load imposed on motor by pump, when pumping at design point. If it is not feasible to use angular contact ball thrust bearing or spherical roller thrust bearing, a plate thrust bearing and sleeve guide bearing may be provided. * Normal or standard minimum life is one year (8,750 hours).
      a. Bearing Temperature Detectors: Motors 200 HP and larger to be provided with bearing temperature detectors.
         1) General. Each bearing shall be provided with 100 ohm platinum resistance temperature detectors (RTDs) each of which will be connected

by conductors to bearing temperature monitor units located remotely. Two (2) base bearing temperature levels are to detected in each bearing: Alarm (on initial rise above normal) and Shut-down (on further rise approaching critical). Winding and Bearing temperature monitors shall be provided and mounted remotely. The monitors shall provide individual indication of each detector. A contact closure shall be wired under Division 16 to the pump controls. Wiring between the detectors and the monitor shall be by the contractor.

2) Installation: Installation procedures and methods shall be as specified by the temperature detector manufacturer.
3) Accessories and Associated Hardware. All types of installation hardware shall be standard items as recommended by the manufacturer for this installation.
4) Detector lengths shall be carefully chosen to coordinate with the assembly of accessories and hardware.
5) Testing and Certification. All detectors shall be tested before installation and all values of resistance and temperature shall be certified including the manufacturer's test points. During factory tests, the performance of all detectors shall be observed and recorded by means of ohmmeters with readings in ohms and equivalent temperatures.
6) Drawings and Bill of Material. Detailed installation drawings and bill of material of detectors and associated hardware shall be submitted with all other shop drawings.

b. Vibration Transmitters:
   1) Motors 200 HP and larger to be provided with vibration transmitters. Provide vibration system capable of monitoring vibration in the x and y axis, and transmitting data to SCADA system via motor monitor relays for indication, report and alarm generation. Transmitters to be equivalent to Model 5484 as manufactured by Metrix Instrument Co. of Houston, Texas. Transmitters are to provide 4-20 mA outputs. Coordinate with SCADA system supplier and electrical contractor. Mount two transmitters 90 degrees apart on the top of each pump motor in accordance with manufacturer's recommendation.
   2) Provide power wiring to control box; conduit and cabling to individual pump motor sensors, and RS485 conduit and cabling to SCADA system. Provide required communications software and field start-up.

6. Lubrication. Oil lubricated motors shall have a visual level indicator, accessible drain plug, and accessible filling plug. The lubrication system shall be so designated as to provide the correct quantity of lubricant with minimum foaming or aeration. Seals shall be of the vacuum-break type to keep oil from the windings.
7. Terminal Boxes. Terminal boxes shall be cast iron or fabricated steel, neoprene gasketed and bolted with adequate space for connections. The motor leads shall be permanently marked in agreement with connection diagram. Watertight terminal boxes shall be provided for connection of the thermal protective circuit and supply conductors.

8. Space Heaters. All motors 75 HP and larger to be provided with suitably sized space heaters which shall be arranged in a uniform design around the interior of the motor for the purpose of maintaining an interior temperature above ambient to prevent the accumulation of moisture within the motor during periods of shutdown. A terminal strip in a terminal connection box for heaters shall be provided. The strip heaters shall be Chromalox Type S-1225, 120 volts, as required for this duty.
   a. Thermostat. A differential thermostat shall be provided for control of the strip heaters. The thermostat, in a NEMA 1 enclosure, shall operate to maintain the interior temperature of the motor at an adequate differential of 0°, minimum, over the ambient temperature. The thermostat shall have an operating range of 0 degrees F to 120 degrees F with a differential range of 0 to 50 degrees.
   b. Mounting and Control. The differential thermostat and its "low" bulb shall be mounted on the motor. The control circuit for the heaters shall be arranged to interlock the strip heaters off when the motor is running.
   c. Bulb Mounting. The motor shall be provided with an insulated holding device to secure the "high" bulb in the upper portion of the motor interior.
9. Corrosion prevention and finish painting. The motor furnished under these Specifications will be subjected to moisture conditions and shall be designed to prevent deterioration from such exposure. The general requirements to be followed to mitigate corrosion are specified below. Any additional special treatment or requirement considered necessary for any individual item specified under the respective item shall be provided by the manufacturer.
   a. Fastenings and Fittings. All screws, bolts, nuts, pins, studs, rings, washers, and other similar fittings shall be of corrosion resisting material or shall be treated in an approved manner to render them resistant to corrosion. Galvanizing, sheradizing, zinc cadmium and copper plating when properly done and of a sufficiently heavy coat are approved corrosion resisting treatments. Other corrosion resisting treatments may be used if approved by the Owner.
   b. Frames. Nonexposed parts of the motor frames if of steel and if they are not coated with varnish during the process of insulating the windings shall be cleaned of rust, grease, mill scales and dirt and then treated with an approved iron and zinc phosphate solution followed by rinsing with a chromic acid solution. If the motor frame is not coated during the process of insulating the windings, then in addition to the above it will be given one coat of zinc chromate primer and then two coats of moisture proof varnish all cured as required.
   c. Cores. The assembled motor cores shall be thoroughly cleaned and immediately primed on all surfaces by applying, except on air-gap surfaces, two coats of an approved moisture resisting and oil resisting insulation varnish.
   d. Shafts. Exposed surfaces of motor shafts, except for bearing surfaces and except for the omission of the iron and zinc phosphate treatment shall be

treated as specified for frames and then given two coats of the moisture proof varnish, each cured as required.

e. Shop and field painting. Shop coatings of all exposed parts shall conform to the requirements of Section 09900, Painting.

10. Sound Levels.
    a. Acoustical Terminology. Acoustical terminology used herein conforms with definitions provided in ANSI S1.1-1960 (R1971). The presentation of any sound power levels provided herein are in accordance with ANSI S1.2-1962 (R1971).
    b. Sound Levels. The maximum noise generated by each motor, including all necessary functional accessories and appurtenances, shall not exceed the sound pressure level shown below, while operating at no load, uncoupled, and at rated voltage.

TABLE 2 – Maximum Sound Power Levels in Decibels Re: 10-12 Watts

Octave Band Center Frequency (Hz)	65	125	250	500	1000	2000	4000	8000
Sound Pressure Level at 1 Meter	96	104	105	105	104	102	100	97

    c. Certificate of Compliance. The motor manufacturer shall guarantee compliance with the sound power level shown 2, for each motor, and shall submit in all cases a certificate of compliance signed by an executive officer of the motor manufacturing company.
    d. Performance Testing. The Engineer will in all cases measure compliance with the guaranteed sound levels during shop testing of the motors. Test procedures will be in accordance with ANSI S1.2 Section 3.4, "Determination of Sound Power in a Free Field Above Reflecting Plane".

11. Manufacturers:
    a. General Electric Company
    b. U. S. Electric Motors
    c. Toshiba.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install each pump in accordance with the manufacturer's literature and recommendations under the supervision of a factory-trained manufacturer's representative.

B. Set the unit level and true, shim to the proper elevation and grout and place using non-shrink, nonmetallic grout as specified in Section 03600.

3.02 FIELD PAINTING

A. Field paint each pump motor, assembly in accordance with Section 09900.

3.03 START-UP AND TESTING

A. Conduct testing in accordance with Section 01650 and details provided hereinafter.

B. Have manufacturer's representative check and approve the installation prior to initial start-up and provide installation certificate prior to initial start-up.

C. Field Testing. Run pumps in the field witnessed by the manufacturer's representative, contractor and Engineer to verify operation under field conditions. Measurements to be taken by the Contractor to verify the head, capacity, efficiency, and horsepower of the pumps at shutoff and the three design points and to determine that the pumping units will operate satisfactory without cavitations, overheating or overloading the motor, and free of vibration throughout the operating range of head and capacity at rated speed. The Engineer will furnish calibrated gauges and meters for the tests. All vibration tests to be conducted in accordance with all applicable regulations of the Hydraulics Institute.

D. Correct all deficiencies to the satisfaction of the Engineer.

E. Have factory-trained manufacturer's representative instruct plant personnel on repair and maintenance of pumping units.

END OF SECTION

SECTION 11216

CHEMICAL TRANSFER PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
1. Provision for horizontal magnetic drive centrifugal pumps to transfer treatment chemicals from bulk storage tanks to day tanks as shown on Drawings and specified herein. All equipment herein to be furnished under Phase 1 construction. Treatment chemicals to be transferred include the following:
   a. Potassium Permanganate
   b. Polyaluminum Chloride
   c. Ferric Chloride
   d. Caustic Soda
   e. Corrosion Inhibitor
   f. Hydrofluosilicic Acid (Fluoride)
   g. Sodium Thiosulfate
   h. Ammonia Hydroxide

B. Related Sections:
1. Section 03600 – Grout
2. Section 09900 – Painting
3. Section 11005 – Basic Equipment Materials and Methods.
4. Section 13410 - Process Monitoring and Control System
5. Division 16 – Electrical.

1.02 SYSTEM DESCRIPTION

A. General: Provide pumps and motors of standard design and construction as fabricated, assembled, and tested by one manufacturer.

B. Design Requirements:

Description	Units	Potassium Permanganate	Ferric Chloride	Polyaluminum Chloride	Caustic Soda	Fluoride	Corrosion Inhibitor	Sodium Thiosulfate	Ammonia Hydroxide
1. General									
a. Type		Magnetic Drive	Magnetic Drive	Magnetic Drive	Magnetic Drive	Magnetic Drive	Magnetic Drive	Magnetic Drive	Magnetic Drive
b. Quantity	each	2	2	2	2	2	2	2	2
c. Suction Dia.	inch	1.5	2	2.5	1.5	1.5	1.5	1	2
d. Discharge Outlet Dia.	inch	1.5	1.5	2	1.5	1.5	1.5	1	1.5

Description	Units	Potassium Permanganate	Ferric Chloride	Polyaluminum Chloride	Caustic Soda	Fluoride	Corrosion Inhibitor	Sodium Thiosulfate	Ammon... Hydroxide
2. Pump Design									
1) Capacity	gpm	37	75	125	75	30	30	25	50
2) TDH**	feet	20	35	35	35	35	35	35	105
3. Misc. Pump Requirements									
a. NPSH Available	feet	20	20	20	20	20	20	20	20
b. Static Suction Lift	feet	1	1	1	1	1	1	1	1
4. Materials in Contact with Chemical									
Thrust Collar (inboard)	material	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE	PTFE
Bushing	material	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon	Carbon
Shaft, Thrust Collar (rear)	material	High Purity Alumina Ceramic	High Purity Alumina Ceramic	High Purity Alumina Ceramic	High Purity Alumina Ceramic	High Purity Alumina Ceramic	High Purity Alumina Ceramic	High Purity Alumina Ceramic	High Purity Alumina Ceramic
Casing Liner, Containment Shell	material	CFRETFE	GFRPP	CFRETFE	CFRETFE	CFRETFE	CFRETFE	GFRPP	CFRETFE
O-ring	material	FKM	FKM	PTFE	EPDM	FKM	EPDM	FKM	PTFE
5. Motor Requirements:									
a. Horsepower	hp	0.5	2	7.5	3	1.5	1.5	0.75	5
b. Voltage	volt	480	480	480	480	480	480	480	480
c. Phase		3	3	3	3	3	3	3	3
d. Nominal Speed	rpm	3,450	3,450	3,450	3,450	3,450	3,450	3,450	3,450
e. Enclosure		TEFC	TEFC	TEFC	TEFC	TEFC	TEFC	TEFC	TEFC
f. Service Factor		1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
6. Model Number		MX-F400CFVX	MX-402CV6	MDM-2526ECF07	MX-F403CFEX	MX-F401CFVX	MX-F401CFEX	MX-251CV6	MDM-2156ECF05
7. Chemical Characteristics									
a. Concentration					50%	23%			19%
b. Specific Gravity			1.40	1.20	1.53	1.20	1.58	1.28	0.93

C. Model Numbers refer to pumps as manufactured by Iwaki Walchem.

D. Coordinate with control description in accordance with Section 13410.

1.03 SUBMITTALS

A. General: Submit shop drawings for transfer pumps in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications including:
   1. Manufacturer's literature, illustrations, specifications and engineering data defining materials of construction, dimensions, weights, pump and motor performance.
   2. Parts list including list of recommended spare parts and maintenance tools.

B. Submit written installation, operation, and maintenance instructions.

1.04 QUALITY ASSURANCE

A. General: Chemical transfer pumps to comply with all provisions of Section 11005.

B. Manufacturers Certification: Provide Manufacturer's certification that all materials in contact with pumped fluid are compatible with chemicals listed in Design Criteria and will operate without damage from chemical being pumped.

1.05 JOB CONDITIONS

A. Wiring: Wiring to and from starters, switches, relays and contacts performed under Division 16 - Electrical.

PART 2 PRODUCTS

2.01 MANUFACTURERS:

A. Acceptable Manufacturers (Magnetic Drive Pumps)
   1. Iwaki Walchem.
   2. March Manufacturing, Inc.

2.02 MAGNETIC DRIVE CENTRIFUGAL PUMPS

A. Materials
   1. Wetted Parts. As stated in Design Criteria.
   2. Stainless steel anchor bolts, length and diameter set by manufacturer.

B. Casing
   1. Vertically split with back pull-out arrangement to maintain impeller without disconnection of piping.
   2. Provide thrust washer and mounting for impeller spindle in casing.

C. Drive
   1. Provide pump coupled to motor through a seal-less magnetic drive.
   2. Drive to consist of drive magnet, impeller magnet, impeller magnet housing, and motor bracket.
   3. Provide O-ring seal between impeller magnet housing and pump casing.
   4. Drive magnet to be completely isolated from pumped fluid.
   5. Drive to act as clutch to prevent motor overload.

D. Baseplate: Provide foot mounted motor suitable for supporting motor and close coupled pump. Furnish with PVC drip pan with ½-inch PVC drain and ball valve for retaining chemical leakage from seals.

2.03 FINISHES

A. Shop coat non-metallic surfaces in accordance with manufacturers standard coating system.

B. Shop coat metallic surfaces in accordance with Section 09900.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install pump in accordance with manufacturer's literature.

B. Set unit level and true, shim to proper elevation and grout in place using nonshrink, nonmetallic grout as specified in Section 03600.

C. Painting
   1. Field paint or touch-up factory coatings for each pump, motor and baseplate in accordance with Section 09900.

3.02 FIELD QUALITY CONTROL

A. Field Test
   1. Manufacturer's representative to check and approve installation prior to initial start-up, and provide installation certificate.
   2. Run pumps in field, witnessed by Manufacturer's representative, Contractor, and Engineer, to verify operation under field conditions.
   3. Measure head, capacity, efficiency and horsepower of pumps at two design points, to determine that pumping units will operate satisfactorily without cavitation, overheating or overloading of motor, and free of vibration throughout entire operating range of head, capacity and speed.

B. Correct all deficiencies to satisfaction of Engineer.

3.03 DEMONSTRATION

A. Startup and test system in accordance with Section 01650.

B. Have factory-trained manufacturers representative instruct plant personnel on repair and maintenance of pumping unit for one 8 hour day.

3.04 PROTECTION

A. After installation, protect drive units from moisture and temperature in accordance with Section 01600. Provide heated covers and enclosures where necessary.

END OF SECTION

SECTION 11218

SAMPLE PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision for furnishing and installing sample pumps (progressive cavity and submersible types) as indicated on the Drawings. All pumping equipment to be furnished as part of Phase 1 construction.

B. Related Sections:
1. Submittals: Section 01300.
2. Testing: Section 01650.
3. Grouts: Section 03600.
4. Paints and Coatings: Section 09900.
5. Basic Equipment Materials and Methods: Section 11005.
6. Division 16 - Electrical.

1.02 REFERENCES

A. American Society For Testing and Materials:
1. ASTM A307, Standard Specification for carbon steel bolts and studs.
2. ASTM A563, Standard Specification for carbon and alloy steel nuts.

1.03 DESIGN REQUIREMENTS

A. Submersible Type Sample Pump
1. Design/Performance Requirements:

Description	Unit No. 1
Rated Capacity	5.0 gpm
TDH at Rated Capacity	75 feet
Maximum Motor Speed	3450 rpm
Motor Rating	1/2 hp
Suction Connection	------
Discharge Connection	1 inch
Liquid Pumped	Screened Raw Water
Duty Rating:	Continuous 24 hours duty

B. Progressive Cavity Type Sample Pump
1. Design/Performance Requirements:

Description	Unit No. 2	Unit No. 3
Rated Capacity	4 gpm	6.5 gpm
TDH at Rated Capacity	35 feet	69 feet
Maximum Motor Speed	1725 rpm	1725 rpm
Motor Rating	½ hp	½ hp
Suction Connection	¾ inch	¾ inch
Discharge Connection	¾ inch	¾ inch
Liquid Pumped	Water	Water
Duty Rating:	Continuous 24 Hours.	

2. Pumps shall be self-priming under a suction lift up to 23 feet.

1.04 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for sample pumps in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications.

B. Submit performance curves and dimensional data in accordance with Section 01300.

1.05 QUALITY ASSURANCE

A. Basis of Design:
   1. Submersible Type Sample Pump: Drawings and Specifications are based on Grundfos Pumps. Assume responsibility for costs resulting from changes to piping, electrical work, etc. for other manufacturer's equipment. Submit drawings to Engineer for approval, showing prepared changes in piping, electrical work, etc.
   2. Progressive Cavity Type Sample Pump: Drawings and Specifications are based on Moyno Pumps. Assume responsibility for costs resulting from changes to piping, electrical work, etc. for other manufacturer's equipment. Submit drawings to Engineer for approval, showing prepared changes in piping, electrical work, etc.

1.06 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Store sample pumps and motors in enclosed, heated building (above 50 degrees F). Elevate equipment off concrete floors.

1.07 PROJECT CONDITIONS

A. Electrical Interface:
   1. Wiring: Wiring of sample pump motors performed under Division 16.

B. Contract Interface:

1. Wiring: Wiring of sample pump motors performed by others under Electrical Work Contract.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Sample Pump Manufacturers:
   1. Submersible Type:
      a. Grundfos Pumps Corp. Clovis, California,
         1) Unit No. 1: Model 5S03-13
      b. Crown
      c. Peerless

   2. Progressive Cavity Type:
      a. Moyno, Interstate Pump Co., Inc.;
         1) Unit No. 2: Model SP33259
         2) Unit No. 3: Model SP33359
      b. Netzsch
      c. Mono

2.02 MATERIALS

A. Bolts and Nuts: hexagon heads. ASTM A307 and ASTM A563.

B. Anchor Bolts: Type 304 stainless steel. Furnish and size in accordance with pump manufacturer's recommendations.

C. Pump Data Plate: Furnish stainless steel data plate securely attached to each unit. Include pump designation, manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating and other pertinent data.

2.03 PUMPS

A. Submersible Type Sample Pumps:
   1. Pump Type: Submersible type providing a positive flow ensuring low shear transmission of liquid pumped.
   2. Material of Construction: Stainless steel fabrication
   3. Direct connect pump to motor and provide means of retrieval of pump for maintenance.
   4. Mount pump on the inside of an existing modified intake screen as shown on drawings.

B. Progressive Cavity Type Sample Pumps:
   1. Pump Type: Progressive cavity type providing a cushioned positive flow ensuring nonpulsating low shear transmission of liquid pumped.
   2. Material of Construction: Cast iron pump housing with 416SS chrome plated rotor, Nitrile stator.

3. Direct connect pump to motor.
4. Furnish formed steel baseplates. Mount each pump and motor to baseplate. No baseplate required for pump placed in inventory.

2.04 MOTORS

A. Submersible Type Sample Pumps:
   1. The submersible motor shall conform to the latest specifications of the National Electrical Manufacturers Association. The motor thrust bearing shall be of ample capacity to carry the weight of all rotating parts plus the hydraulic thrust of the pump unit. It shall also have ample capacity to permit the pump to operate for short periods with the discharge valve closed. The motor shall have full thrust capacity regardless of direction of rotation and shall be non-overloading throughout the pump range.
   2. The motor shall be of the squirrel cage, induction type, suitable for "across the line" starting and shall be capable of continuous operation under water at the conditions specified.
   3. The motor take-off shaft shall be Type 416 SS or equivalent corrosion-resistant material. All fastenings or material exposed to the pumped water shall be of stainless steel or equivalent corrosion-resistant material.
   4. Submersible Cable: The cable shall comprise three or more separate conductors or a single jacketed, three-conductor assembly. Each conductor shall be insulated with synthetic rubber or plastic suitable for continuous immersion in the fluid being pumped. When three or more single conductors are used, each must be jacketed. When a three or more conductor cable is used, it must be jacketed. The jacket material must be oil and water resistant, synthetic rubber or other suitable mechanical protective material. The cable shall be sized to limit the voltage drop to 5 percent at the motor terminals.
      a. One foot of extra cable for each fifty (50) feet of setting shall be allowed to compensate for possible twist or sag of the cable during installation plus twenty-five (25) feet, unless otherwise specified, for beyond the surface plate. The cable shall be suitably supported from the column with corrosion resistant clamps at a number of points adequate for cable used. All cable fittings and terminals shall be watertight at the pressure encountered in the application.
      b. The electrical conductors shall be protected by a metal guard where they pass the pump bowls. Splice kits shall be provided to make all necessary connections. The splice shall be watertight.
   5. Motor Manufacturer:
      a. Franklin
      b. General Motors

B. Progressive Cavity Type Sample Pumps:
   1. Motors: ½ HP, built-in overload protection, totally enclosed, fan cooled, and rated for continuous duty. Electrical characteristics: 120 volts, 1 phase, 60 Hz.
   2. Disconnect Switches: Furnish each pump with separate disconnect switch.

Disconnect Switches: Furnish each pump with separate disconnect switch.

2.05 FINISHES

A. Shop Prime: Pumps and motors in accordance with Section 09900.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install sample pumps in conformance with Section 11005 and as indicated on Drawings.

B. Install each pump in accordance with the manufacturer's literature.

C. Mount the pumps and motors on common steel baseplate.

D. Set units level and true, shim to proper elevation and grout in place using nonshrink, nonmetallic grout as specified in Section 03600.
   1. Allow 1-1/2 inches for grout when pouring the foundation.

3.02 PAINTING

A. Field paint: Paint each pump, motor and baseplate in accordance with Section 09900.

3.03 FIELD QUALITY CONTROL

A. Sample Pump Testing: Section 01650 for general testing requirements.

B. Field Testing: Run pumps in the field, witnessed by Engineer, to verify operation under field conditions. Determine that pumping units will operate at specified head and capacity satisfactorily without cavitation, overheating or overloading of motor, and free of vibration throughout entire operating range of head and capacity at rated speed.

C. Correct all deficiencies to satisfaction of Engineer.

3.04 SCHEDULES

A. Sample Pump Schedule:

Designation	Type	Unit Number	Description	Location
SP-149	Submersible	1	Raw Water Sample (Pre-treated)	RWPS - Caisson Stilling Well
SP-259	Progressive Cavity	2	Raw Water Sample (Post -treated)	1st Floor WTP, PACL Room
SP-289	Progressive Cavity	2	Mixed Water Sample	1st Floor WTP, Mixed Water Chamber
SP-349	Progressive Cavity	3	Filter Influent Sample	Pipe Gallery
SP- 359	Progressive Cavity	3	Combined Filter Effluent Sample	WTP UV Room
P-639A	Progressive Cavity	3	Clearwell Influent Sample	WTP UV Room
P-639B	Progressive Cavity	3	Clearwell Effluent Sample	WTP HSPS – Basement Level
SP- S1	Submersible	1	Spare	Inventory - Stock
SP- S2	Progressive Cavity	2	Spare	Inventory - Stock
SP- S3	Progressive Cavity	3	Spare	Inventory - Stock

END OF SECTION

SECTION 11221

FLOCCULATION EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision for horizontal reel flocculators with motor drive and appurtenant system components. Provide equipment in four (4) basins for Phase 1 construction and in one (1) basin for Phase 2 construction.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Products: Section 01600.
   3. Alternatives: Section 01100.
   4. Testing: Section 01650.
   5. Paints and Coatings: Section 09900.
   6. Basic Equipment Materials and Methods: Section 11005.
   7. Division 16-Electrical.

1.02 REFERENCES

A. American Gear Manufacturers Association:
   1. AGMA Standards.

B. American National Standards Institute:
   1. ANSI Standards.

C. American Society for Testing and Materials:
   1. ASTM A36, Standard Specifications for Structural Steel.
   2. ASTM A48, Standard Specifications for Gray Iron Castings.
   3. ASTM D570, Standard Test Method for Water Absorption of Plastics.
   4. ASTM D4020, Standard Specification for Ultra-High-Molecular-Weight Polyethylene Molding and Extrusion Materials.

D. American Welding Society:
   1. AWS D1.1, Structural Welding Code.

E. Institute of Electrical and Electronics Engineers, Inc.:
   1. IEEE Standards.

F. National Electrical Manufacturers Association:
   1. NEMA Standards Publications.

1.03 DEFINITIONS

A. Paddle Assembly: Assembly comprised of paddle arms and paddles connected to shaft.

B. Flocculator Mixing Unit: System comprised of single or multiple paddle assemblies connected to a single shaft.

C. Velocity Gradient: Square root of power loss due to liquid shear per unit volume of water divided by dynamic viscosity.

D. Compartment: A sub basin component separated from others by a wall oriented parallel to flow.

E. Stage: A sub basin component separated from others by a wall oriented perpendicular to flow.

1.04 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Provide horizontal reel flocculator equipment in four (4) flocculation basin(s) as part of Phase 1 construction and in one (1) flocculation as part of Phase 2 construction as indicated on Drawings.
   2. Each flocculator basin is divided into 2 parallel compartments with 3 stages per compartment.
   3. In each flocculator basin, provide 2 flocculator mixing unit(s) in each parallel compartment, 1 for Stage 1 and 1 for Stages 2 and 3.
   4. Provide 1 flocculator reel paddle assembly on each mixing unit shaft in each stage.
   5. In each flocculator basin, provide 1 common drive(s) for the Stage 1 mixing unit(s) and 1 common drive(s) for the Stage 2 and Stage 3 mixing unit(s).
   6. Mixing unit shaft is oriented parallel to direction of flow through the basin.

B. Performance Requirements:
   1. Criteria for Performance Calculations:
      a. Drag Coefficient (Cd-Dimensionless): For power and velocity gradient calculations assume water rotating with paddle tip, minimum drag coefficient is 1.8 and paddle velocity is 0.75 times actual tip speed.
   2. Each flocculator mixing unit designed to operate in its compartment as indicated on Drawings and as specified below:

	Units	Stage 1	Stage 2	Stage 3
Number of Compartments per Stage	ea.	2	2	2
Size of Compartments	ft.	14.7 W x 15.8 L	14.7 W x 15.8 L	14.7 W x 15.8 L
Average Side Water Depth	ft.	14.7	14.7	14.7
Volume per Compartment	gal.	25,500	25,500	25,500
Total Volume per Stage	gal.	51,000	51,000	51,000

	Units	Stage 1	Stage 2	Stage 3
Design Flow Rates per Basin per Compartment	 mgd mgd	 6.7 3.0	 6.7 3.0	 6.7 3.0
Maximum Velocity Gradients	sec^{-1}	75	50	35
Design Temperature	°F	35	35	35
Maximum Tip Speed	fps	3.0	3.0	3.0
Maximum Paddle Assembly Diameter	ft	13.7	13.7	13.7
Minimum Paddle Assembly Diameter	ft	11.7	11.7	11.7
Maximum Paddle Size	in.	6	6	6
Maximum Paddle Length	ft.	12.7	12.7	12.7
Maximum Motor Horsepower	hp	7.5*	5**	5**
Minimum number of arms per assembly	ea.	4	2	2
Minimum number of paddles per arm	ea.	3	3	2

* Stage 1 has combined driver
**Stage 2 & 3 have combined driver

C. Paddle assembly bearings, chain drives and sprockets to be interchangeable for both all stages.

D. Drivers: Provide 2 drives per flocculator basin, 1 drive for Stage 1 and 1 common drive for Stages 2 and 3. The drive for Stage 1 drives 2 mixing units and the drive for Stages 2 and 3 drives 2 mixing units.

E. Equipment designed for continuous twenty-four hour operation. Provide mechanism parts amply proportioned for stresses occurring during fabrication, erection and operation.

1.05 SUBMITTALS

A. Product Data: Submit Product Data for following:
   1. Drive and connecting chains.
   2. Chain sprockets.
   3. Bearings.
   4. Chain tightener.
   5. Speed reducer.

6. Motor.

B. Shop Drawings: Submit Shop Drawings for flocculation equipment in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications.

C. Additional Information: In addition to shop drawings specified in Section 01300 and Section 11005, submit following information for approval by Engineer:
   1. Operating loads at points of supports.
   2. Proposed design and dimensions of baffle wall support brackets.
   3. Details of connection at support points.
   4. Details of wall and floor openings required for drive system and bearings.

D. Quality Assurance/Control Submittals:
   1. Design Calculations: Submit following design calculations for Engineers approval to substantiate proposed flocculator design:
      a. Shaft and bearing sizes.
      b. Paddle arm and plate connection sizes.
      c. Flocculator paddle sizes and configurations.
      d. Motor and drive sizes.
   2. Certificates: Submit following notarized certificates.
      a. Welding.
      b. Paint preparation and application.
      c. Proof tests of drive and connecting chains.

1.06 QUALITY ASSURANCE

A. General Requirements: Comply with provisions of Section 11005.

B. Qualifications:
   1. Manufacturer's Experience: Minimum of 10 years experience in design and supply of horizontal flocculators.
      a. Provide list from equipment manufacturer of 5 similar size installations utilizing horizontal flocculators.
   2. Welder Qualifications: Welds will be made only by welders, tackers and welding operators currently qualified by tests as prescribed in Structural Welding Code, AWS D1.1 to perform type of work required.

C. Basis of Design: Drawings and Specifications are based on Jim Meyers & Sons, Inc. flocculation equipment. Assume responsibility for costs resulting from changes to structure, piping, electrical work, etc., required for US Filter, Dorr Oliver/Eimco or other approved flocculation equipment, in accordance with Section 01100. Submit drawings to Engineer for approval, showing proposed changes in structure, piping, equipment, electrical work, etc.

D. Responsibility: To ensure equipment required for installation of flocculators and controls is properly coordinated and functions in accordance with intent of Specifications, obtain equipment specified under this Section from a single supplier in whom responsibility for proper function of equipment, regardless of manufacturer, as an integrated and coordinated system is vested. Intent of this paragraph is to establish unit responsibility for equipment

with flocculation equipment supplier. Use of word "responsibility" relating to flocculation equipment supplier is not intended to relieve ultimate responsibility for equipment coordination, installation, operation, and guarantee.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Store speed reducers and motors in enclosed, heated buildings (above 50 degrees F.). Elevate equipment off concrete floors.
   2. Store shop primed metals to prevent degradation of coatings.
   3. Store chains, sprockets and bearings in accordance with manufacturer's instructions.

B. See Section 01600 for general handling, storage, and protection requirements.

1.08 PROJECT CONDITIONS

A. Electrical Interface:
   1. Variable frequency drives and local control stations provided as work of Division 16 of these Specifications.
   2. Wiring: Wiring of flocculator motors performed under Division 16 of these Specifications. Have supplier certify that motors supplied under this Section are suitable for operation with specified drives.

1.09 MAINTENANCE

A. Extra Materials: Furnish following spare parts to Owner. Replace extra parts installed during guarantee period.
   1. One set driver sprocket segments.
   2. One set driven sprocket segments.
   3. One drive chain.
   4. Two sets cross drive sprocket segments.
   5. One takeup sprocket.
   6. One connecting chain.
   7. One motor - each size.
   8. Five flocculator paddles of each size

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Flocculator Manufacturers:
   1. Jim Myers & Sons.
   2. US Filter.
   3. Dorr Oliver/EIMCO, Process Equipment Company.

2.02 MATERIALS

A. Structural Steel: Conforming to ASTM A36.

B. Iron Castings: Close-grained gray iron, free of blow holes, flaws, or excessive shrinkage and conforming to ASTM A48.

C. Anchor Bolts: Type 304 stainless steel of ample size and strength for intended purpose. Furnish anchor bolts with equipment, and set in accordance with manufacturer's instructions.

2.03 COMPONENTS

A. Paddle Assemblies: Each paddle wheel assembly consists of paddle arms fixed in position between two fabricated steel hubs welded or keyed to shaft. Each paddle arm consists of two structural steel angles, protruding from steel hubs, to which paddle blades are attached.
   1. Paddle Blades: Fabricated of fiberglass, bolted to steel angles.
   2. Paddle Arms: Base bid to use 304L SS paddle arms fastened to 304L SS paddle shaft. Alternative bid to use carbon steel paddle arms fastened to carbon steel paddle shaft. Size paddle arms so that tip deflection is less than 1/360 of arm length at full operation. Paddle arms to be removable, but secured to paddle shaft in a manner that will not slip while in service. Bolt stainless steel or steel angles diagonally to paddle arms to serve as bracing.
   3. Provide Type 304 stainless steel submerged mounting hardware, fasteners and anchor bolts with self locking nuts.
   4. Shaft: Sized within stress limitations at full operating load and within deflection limitations under dry loads. Shaft constructed of 304 L SS for base bid and solid steel shafting for alternate bid, straight and true, and arranged parallel to flocculator flow. Pipe shafts are not acceptable. Shaft deflection is not to exceed 1/32 inch per foot of shaft length and 0.50 degree torsional deflection at maximum HP. Weld or key hubs for paddle wheel assemblies to shaft and adequately size to transmit maximum torque. Shafting is to be polished at each bearing.
   5. Shaft Support: Support shaft at intervals indicated on Drawings by water lubricated split cast iron journal bearings with adjustable base plates and replaceable UHMWP liners. Bearing liner is to have a length to diameter ratio of at least 2:1 and a grease fitting provided for dry operation. Provide locking collars to prevent longitudinal movement of shaft. Placement of locking collar established at time of installation to provide for thermal expansion and contraction.Couplings: Locate one compression coupling on each side of center bearing to allow removal of a single paddle assembly. Key seat coupling ends of shaft to accommodate a rigid ribbed cast iron compression coupling. Couplings designed to transmit torque and axial thrust loads.

B. Chain and Sprockets:
   1. Drive Chain

a. Chain: 2.609 inch pitch 88 Class with 7/16 inch diameter pins and a weight of not less than 3.8 pounds per foot. Each connecting link pinned and cottered. Cotters constructed of Type 300 Series stainless steel.
b. Bushings: 7/8 inch diameter Type 400 Series stainless steel through hardened to 40-45 RC.
c. Side Bars: 15/64 inch x 1-1/8 inch minimum dimension Type 400 Series stainless steel through hardened to 40-45 RC.
d. Chain Pins: Type 400 Series stainless steel heat treated to a hardness of 40-45 RC. Provide pins with Type 300 stainless steel J or T head cotters.
e. Provide assembled chain with an average ultimate strength of 24,000 pounds. Chain lengths to be proof tested at a minimum load of 12,000 pounds to remove defective links, and not cause damage or distortion to chain.
f. Chain barrel to have a diameter along its full working length to allow for proper engagement with a 1 inch maximum face with number H-78 sprocket.
g. Provide chain capable of being disassembled and assembled in field.
h. Provide chain constructed in accordance with acceptable chain manufacturing practice, including link squareness and removal of burrs.
i. Select chains to operate at less than their catalog rating under normal operating conditions.

2. Connecting Chain:
   a. Chain: NMX-78 non-metallic, having 2.609 inch pitch links with an average weight of 1.3 to 1.4 lb. per foot. Provide chain with a rated catalog working load of not less than 1750 lbs., based on strength and wear considerations.
   b. Chain Links: Manufactured of acetal resin with barrel and side bars integrally molded to ensure squareness of links. Chain barrel to have a diameter along its full working length to allow proper engagement with a 0.94 inch maximum face width of drive sprocket. Chain links connected with 300 Series stainless steel pins.
   c. Pins: Constructed to prevent rotation and held in place without use of pins or cotters. Pins diameter of 7/16 inch. Provide chains with minimum ultimate strength of 4,500 lbs. Chains proof tested at a load of 3000 pounds, and no damage or distortion to chain resulting from proof loads.
3. Chain Guards: Provide chain guards fabricated from No. 14 gauge steel, hot-dip galvanized after fabrication.
4. Chain Sprockets: Provide chain sprockets with cast iron hubs and UHMWP segmental teeth secured with 316 stainless steel bolts. UHMWP is composed of virgin material conforming to ASTM D4020 with a molecular weight exceeding 4 and intrinsic viscosity greater than 24. Water absorption after 24 hour emersion is nil per ASTM D570. Sprocket teeth formed accurately to fit the chain, and each sprocket firmly keyed to shaft. Drive sprockets to have a shear pin at the hub to prevent overload, and the driven and cross driven sprockets will be of split design to facilitate maintenance and replacement.

C. Drive Units: Each drive unit consists of an induction motor and right angle gear drive speed reducer. Provide motor and drive system size designed to meet application. Provide right angle gear drive speed reducer fully housed, running in oil and of an approved make with antifriction bearings throughout. Provide speed reducer sized in accordance with AGMA

Standards for 24 hour continuous service. Each induction motor to be driven by a variable frequency drive controller provided under Division 16 of these specifications which varies frequency between 6 and 60 hertz to obtain speed ranges over a 10:1 range. Provide each individual component of equipment and entire system as a whole, suitable in all respects for continuous, uninterrupted, 24-hour per day operation. Additionally, provide each unit designed for a damp corrosive exterior environment. Minimum AGMA service factor for drive is 1.5 based upon motor nameplate horsepower.

1. Motors: Minimum horsepower as indicated in design criteria, nonoverloading, conforming to applicable ANSI, NEMA, and IEEE Specifications, and of totally enclosed, fan cooled type with Class F Insulation, designed for operation on 3 phase, 60 hertz, 460 volts. Provide motor of Premium Efficient design and include a normally closed thermostat imbedded in windings for overheat protection. Motors sized on basis of theoretical developed horsepower at design "G" values, plus miscellaneous friction and chain drive efficiency, and an additional safety factor of 1.5.
2. Motor Manufactures:
   a. GE.
   b. US.
   c. Reliance.
3. Drive mechanism for each unit includes driver sprocket, driven sprocket, drive chain, chain tightener, chain guard and necessary anchor bolts.

2.04 FINISHES

A. Shop Priming: Shop blast clean and prime ferrous metals. Shop prime galvanized metals. Shop blast cleaning and painting to conform to Section 09900.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install flocculation equipment in conformance with provisions of Section 11005 and as indicated on Drawings.

B. Structural Design: Incorporate approved flocculator drive and support details into flocculator basin structural construction.

C. Painting: Finish field paint equipment in accordance with Section 09900. Color of flocculator drive unit and chain guard to be selected by Owner.

3.02 FIELD QUALITY CONTROL

A. Field Tests: Perform field tests on one installed flocculator assembly to verify paddle wheel design provides sufficient energy input to water to meet the specified total velocity gradient.
   1. Run tests in wet and dry conditions. Determine frictional loss due to bearings during dry run. Conduct wet run with basin filled to normal operating depth with unit at designed operating speed. Calibrated test instruments and equipment

necessary for tests in addition to continuous technical assistance and supervision of tests is to be furnished by Manufacturer.

2. Conduct tests in presence of Engineer. Record power draw of each motor. Submit 4 copies of a final test report not later than 6 weeks after completion of test. Calculate energy input to water determined by using data from test and drive efficiencies provided by motor and gear reducer manufacturers. Velocity gradient data must not deviate from specified values by more than ±5%.
3. In event equipment does not meet above design criteria, modify equipment to degree necessary to enable equipment to meet above requirements, at no additional expense to Owner.

B. Manufacture's Field Services: Provide a manufacturer's factory trained engineer for instruction or supervision of installation in accordance with Section 11005.

3.03 DEMONSTRATION

A. Starting of System: Startup of system in accordance with Section 01650.

B. Training Owners Personnel: Manufacturer's factory trained engineer to demonstrate and train Owner's personnel for two 8 hour day(s).

3.04 PROTECTION

A. After installation, protect drive units from moisture and temperatures below specified limits. Provide covers and heated enclosures where necessary.

END OF SECTION

4. Drive Unit: Drive unit consists of an induction motor and a right angle gear drive. The motor and drive system size is to be designed to meet the application. The system has been designed around a 20 horsepower maximum 1800 RPM fixed speed gear drive and inverter duty motor. Mixer speed will be varied using AC variable frequency drives (VFDs) as specified in Section 16478 of these specifications. Each individual component of equipment and the entire system as a whole shall be suitable in all respects for continuous, noninterrupted, 24-hour per day operation. The rapid mixer shall be designed for a damp corrosive environment. The motor shall be TEFC, chemical and inverter duty. The drive's minimum AGMA service factor based upon motor nameplate horsepower shall be 1.50.

1.04 SUBMITTALS

A. General: Submit, in accordance with these Specifications and Section 11005, shop drawings for the rapid mixers demonstrating compliance with these Specifications.

B. Additional Information: In addition to shop drawings specified in these Specifications and Section 11005, submit the following additional information for approval by the Engineer:
   1. Operating loads at points of support.
   2. Details of connections at support points.
   3. Design calculations to substantiate shaft and impeller design and configuration.
   4. Critical speed of rapid mixer system.

C. Chamber Design: If baffles are required (as described in Article 1.03.A.3.), the mixer manufacturer shall submit dimensioned drawings for anti-vortexing baffles. Anti-vortexing baffles shall be subject to the approval of the Engineer and shall be included at no additional cost to the Owner.

D. Furnish installation certificate in accordance with Section 11005.

1.05 QUALITY ASSURANCE

A. General: The rapid mixer equipment shall comply with all provisions of Section 11005 - General Equipment Requirements.

B. Basis of Design: The Drawings and Specifications are based on Philadelphia Mixer Equipment. Any costs resulting from changes to the structure, piping, electrical work, etc. required for equipment supplied by Lightnin shall be born by the Contractor. The Contractor shall submit drawings to the Engineer for approval, showing proposed changes in the structure, piping, equipment, electrical work, etc.

C. Responsibility: To ensure that all the equipment required for the installation of the rapid mixers is properly coordinated and will function in accordance with the intent of these Specifications, the Contractor shall obtain all the equipment specified under this Section, from a single supplier in whom the responsibility for the proper function of all the equipment, regardless of manufacturer, as an integrated and coordinated system shall be vested. The intent of this paragraph is to establish unit responsibility for all the equipment

with the rapid mixer equipment supplier. The use of the word "responsibility" relating to the rapid mixer equipment supplier is in no way intended to relieve the Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

1.06 PROJECT CONDITIONS

A. Electrical Interface:
   1. Variable frequency drives provided as work of Division 16 of these Specifications.
   2. Wiring: Wiring of rapid mixer motors performed under Division 16 of these Specifications. Have supplier certify that motors supplied under this Section are suitable for operation with specified drives.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Philadelphia Mixers Corporation, Palmyra, PA.

B. Lightnin, Rochester, NY.

2.02 MATERIALS

A. Structural Steel: Conforming to ASTM A36.

B. Iron Castings: Close-grained gray iron, free of blow holes, flaws, or excessive shrinkage and conforming to ASTM A48.

C. Anchor Bolts: Type 304 stainless steel of ample size and strength for intended purpose. Furnish anchor bolts with equipment, and set in accordance with manufacturer's instructions.

2.03 COMPONENTS

A. Rapid Mixer-Impeller-Shaft System:
   1. The lower mixer shaft shall be connected to the drive output shaft, by means of a rigid flanged coupling, of either the welded or interference fit hub type. Mating coupling faces shall have a rabbeted male and female piloted connection for accurate concentricity, and shall not require match marks for alignment. The coupling shall be accessible from the operating platform and shall permit removal of drive without requiring removal of the impeller and shaft system from the basin. The coupling shall be constructed of Type 316 stainless steel.
   2. The shaft shall be constructed of Type 316 stainless steel, and shall be designed such that the maximum stress shall not exceed 8,000 psi under maximum operating loads. It shall be of overhung design - the use of underwater steady bearings is not permitted. Lower shaft straightness, rigid coupling squareness, and output shaft accuracy must be such that the maximum total indicated runout at the lower end of the shaft does not exceed 1/8-inch for every 10 feet of overhang, as measured when turning over by hand. The shaft shall be designed in

sections where required by the conditions of the project, to facilitate installation and removal from the basin.

3. The impellers shall be of the vertical flat blade design. Impellers and all submerged hardware shall be constructed of Type 316 stainless steel, shall be of bolted construction and shall be connected to the agitator shaft with a hook key for maximum security. The height of the impellers above the floor slab shall be established by the manufacturer to satisfy the mixing requirements specified in The Design Criteria. A keyway shall be provided to allow for vertical adjustment of the impellers ±12-inches in 3-inch increments.
4. The maximum stress in any impeller component shall not exceed 11,000 psi under maximum operating loads.
5. The shaft-impeller system design shall be such that its operating speed shall not exceed 70% of its first lateral critical speed. The shaft shall be safe for operation when the liquid level passes through the impeller while the mixer is running.

B. Geared Speed Reducer and Drive:

1. The geared speed reducer shall be a heavy-duty right angle gear unit completely enclosed in a housing of cast iron or fabricated steel construction. The geared speed reducer shall be specifically designed for rapid mixing service and shall be suitable for direct connection, through a flexible coupling to an electric motor drive. General maintenance, specifically including motor changes, gear changes, bearing replacement (except the bearings supporting the impeller or paddle shaft) and maintenance of the oil lubricating system shall not require the removal of the geared speed reducer housing from its mounting bracket.
2. All gearing shall be designed, constructed, stamped and rated for the AGMA service factor specified herein, and shall be either all helical or a combination of spiral bevel and helical design. Worm gear drives are not acceptable. Gearing shall be of AGMA Quality No. 10 or better, per AGMA 390.03. Full load operating noise levels of the mixer drives shall meet current OSHA occupational noise standards, and/or AGMA 297.01, "Sound for enclosed helical, herringbone, and spiral bevel gear drives", and shall not exceed 85 dBA at 3 feet from any part of the drive assembly. The manufacturer shall certify that all gearing was designed in accordance with AGMA standards.
3. The thermal rating of the gear reducer shall exceed the design mechanical rating to preclude the need for external cooling equipment. External cooling devices are not acceptable. The manufacturer shall certify that these criteria have been adhered to.
4. The geared speed reducer housing shall be of heavy close-grained cast iron or fabricated steel construction capable of withstanding all loads imposed on the unit. Housing assembly shall be mounted on a heavy cast iron or fabricated steel base. The base shall be sufficiently rigid to transmit all torque loading, shock and other loads to a steel leveling plate by bolting thereto as shown on the Drawings. Lifting lugs shall be provided on the housing. A stainless steel AGMA nameplate shall be suitably attached.
5. The mixer gear drive shall be designed such that the gearing is isolated from unbalanced hydraulic loading on the mixing impeller by means of separate agitator shaft bearings located above and below the main drive bearings. The

agitator shaft shall pass through the drive's hollow quill drive shaft and shall be connected to that drive shaft by means of a torsionally resilient flexible coupling.

6. All drive bearings shall be of the antifriction type ball or roller bearings. All bearings within the drive, including output shaft bearings, shall have minimum AFBMA B-10 lives of 100,000 hours when operated at nameplate horsepower and design speed.
7. Lubrication of each geared speed reducer shall be by means of an efficient oil splash mechanism. The drive shall be provided with a dipstick or a sight glass to observe oil level. Each drive must have an effective drywell feature to eliminate oil leakage down the output shaft. Output shaft bearings may be grease lubricated, including a high quality lip seal to retain grease. All oil fill and drain lines and grease fittings shall be located so as to be easily accessible.
8. All gears and bearings shall be protected from rusting while being stored by the application of a shop-applied protective coating.
9. The motor shall have a service factor of 1.0 designed for 24 hour a day operation. Insulation shall be Class F and the temperature rise by resistance under normal operating conditions shall not exceed 75 degrees C. above ambient. Motor to be rated for inverter duty. Provide TEFC enclosure

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install rapid mixer in place as shown on the Drawings and in accordance with the requirements of Section 11005.

3.02 PAINTING

A. General: All painting shall be in accordance with Section 09900.

3.03 START-UP

A. General: Start-up and testing shall be in accordance with Division 1 of these Specifications.

B. Field Tests: Perform tests on the installed rapid mixer equipment to verify that the impeller design provides sufficient energy input to the water to meet the specified horsepower.
    1. Run the tests in wet and dry conditions. Determine the frictional loss due to the bearings during the dry run. Conduct the wet run with the basin filled to normal operating depth with the unit at maximum speed. Calibrated test instruments and all equipment necessary for the tests in addition to continuous technical assistance and supervision of tests to be furnished by the Manufacturer.
    2. Conduct the tests in the presence of the Engineer. Record the power draw of the motor. Submit four (4) copies of a final test report not later than six (6) weeks after completion of the test. Calculate the energy input to the water determined by using the data from the test and drive efficiencies provided by the motor and gear reducer manufacturers.
    3. In the event the equipment does not meet the above design criteria, the equipment shall be modified to meet the design criteria, at the Contractor's expense.

a. Maximum Flow From Each Unit: 250 gpm.
b. Required Rate Of Travel Capability: 1.5 fpm.
c. Direction of Operation: Bi-Directional.

B. Performance Requirements:
1. The sludge collection mechanism will be used to remove accumulated solids from the floor of the clarifier basins. The accumulated solids will contain quantities of coagulant, coagulant aid polymer, and other solids typical of a surface water treatment plant.
2. Sludge will be withdrawn from the basin floor by two header pipes with orifices and discharged from the basin through a telescoping piping arrangement. Flexible hoses will not be permitted.
3. Flow from each basin will be controlled by the electrically actuated modulating valves specified under Section 13420. Removed sludge will flow by means of differential head from the clarification basins to a sludge thickener located onsite.
4. The sludge collection mechanisms will be required to thoroughly clean the floor of a clarification basin fifteen (15) times per day removing settled material up to 3 percent in concentration.
5. Travel along the floor of the clarifier basin must be accomplished without undue disturbance and re-suspension of the settled solids.

1.04 SUBMITTALS

A. Shop Drawings and Product Data:
1. Submit complete shop drawings of all equipment furnished including cut sheets describing purchased sub-components with the specific sub-components used for this Project properly highlighted.
2. All submitted information must include a certification that the submittal describes exactly the equipment to be provided.

B. Operation and Maintenance Manuals:
1. Operation and maintenance manuals shall be provided by the equipment manufacturer at least two weeks prior to shipment of all major equipment components. In addition to requirement of Section 01300, each manual shall be an indexed binder prepared specifically for this Project rather than general equipment instructions. As a minimum, the manual is to contain the following:
a. General arrangement drawings.
b. General arrangement detail drawings
c. Erection drawings
d. A complete bill of materials for the equipment.
e. Installation and maintenance instructions for the specific equipment including the erection sequence and maintenance and trouble-shooting check points.
f. Cut sheets for all items of equipment purchased from other manufacturers.
g. A list of the sludge collector manufacturer's recommended spare parts specifically denoting wear items, long delivery items, and all items convenient for stocking as optional replacement items.

h. Description of operation.

1.05 QUALITY ASSURANCE

A. The manufacturer of the sludge collection mechanism will utilize his standard equipment to meet the minimum values specified for dimensions, design, and intent of this specification.

1.06 DELIVERY, STORAGE, AND HANDLING

A. All components must be erected immediately upon receipt from the manufacturer or stored in strict conformance with storage recommendations provided by the manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Meurer Research, Inc., Golden, Colorado.

2.02 GENERAL

A. The sludge collection equipment shall be suitable for the removal of sludge produced during the settling of chemically treated surface water. Settled solids of up to one quarter inch in diameter will be removed from the sedimentation basin floor by means of suction and then discharged from the basin. Each sludge collector will have its own motor powered, underwater cable drive.

2.03 COLLECTOR ASSEMBLY

A. Each sludge collector assembly shall consist of two pairs of sludge collection pipes which are connected to a central telescoping sludge conduit. The central telescoping sludge conduit shall consist of one larger diameter and one smaller diameter pipe, the smaller one of a diameter such that it will nest inside the larger pipe as the sludge collection assembly is retracted.

B. The sludge collection pipes shall have helical flow orifices designed to allow the flow to enter tangentially into the pipe for efficient sludge removal. The manufacturer shall determine the appropriate number, spacing, and angle of the orifices for the most efficient removal of the settled sludge.

C. The connection between the two pipes of the central telescoping sludge conduit shall be sealed with a UHMW seal.

2.04 DRIVE ASSEMBLY

A. Each sludge collection assembly shall have its own drive. This drive must be a self-contained, totally cable operated motor driven module that quickly and easily attaches

to the sludge collection assembly. The sludge collection assembly shall be driven along the bottom of the basin with a cable.

B. The structural frame and components of the drive assembly shall be constructed of type 304 stainless steel. Components will be of welded construction with all welds continuous, ground smooth and provided with a satin finish to match the header pipe.

C. The drive assembly shall consist of a reversible electrical motor. It will drive the sludge collection assembly longitudinally in the basin.

D. The drive assembly shall include and overload protection device that will not allow excessive loads to be transmitted to the drive cable.

E. The drive cable shall be Type 304 stainless steel, with a minimum diameter of 3/16 inches.

F. Rate of travel for the drive assembly shall be variable in three increments between 0 and 1.5 feet per minute.

G. The drive assembly shall be capable of enduring an indefinite stall without incurring damage and without requiring a manual reset operation.

H. The drive assembly shall have position sensors to determine the location of the collection assembly.

2.05 SLUDGE COLLECTION PIPES

A. Length of each header pipe will be 7 feet 6 inches. The header pipe diameter will be a minimum of 3 inches.

B. Sludge collection header pipes and related components shall be constructed of type 304 stainless steel. All weldments on the header pipe will be continuously welded, ground smooth and provided with a satin finish.

C. Each header pipe will be supplied with removable plastic insert end caps fastened with stainless steel set screws.

D. The sludge collection pipes shall have orifices to collect and regulate sludge flow when traveling in either direction. The manufacturer shall determine the appropriate number, spacing, and angle of the orifices for the most efficient removal of the settled sludge.

E. Header pipes will be provided with stainless steel fixtures to permit convenient attachment to the drive assembly.

F. Header pipes will be fitted with removable skids or wheels designed to minimize any rocking motion and to keep the assembly centered in the basins.

2.06 LOCAL CONTROL PANEL AND CONTROLS

A. The Sludge Collection System (SCS) controls shall be contained within the SCS Control Panel, including PLC-XX, power supplies, control relays, lights, terminal blocks, switches, etc. All system equipment shall be controlled from the SCS Control Panel.

B. Control panel with Hand Off Remote selector switches necessary for controlling a unit must be provided with the capacity to control all necessary functions for operation of the sludge collection mechanisms including the sludge blowdown valves. In the hand position, the system shall travel through and complete round trip. In the remote position, the trip selection, speed and sequencing shall be via PMCS and the programming provided to the programmer.

C. The control panel shall conform to NEMA 4X requirements having a minimum size of 3'-0" wide X 1'-0" deep by 4'-0" high.

D. The control panel shall contain a Bristol Babcock Control Wave PLC suitable for interfacing with the plant Process Monitoring and Control System (PMCS) system via an Ethernet connection. The work to be coordinated with the PMCS vendor to assure compatibility of the two systems.

E. A hinged front door shall be provided on the control panel adequately sized to maintain all of the required equipment with access for repairs.

F. The control panel shall include a distributed control unit (PLC-XX) provided under this Section. The PLC will contain the logic components, including time clock and programmable controls to operate the system.

G. Controls within the local panel shall be 24-volt dc.

H. The following indicators and control devices shall be mounted on the front of the panel:
   1. Unit **HAND-OFF-REMOTE**" selector switches for each unit
   2. Unit "**RUN**" indicating lights for each unit
   3. Unit "**DIRECTION**" selector switch for each unit
   4. Valve Open/Close buttons for each valve with valve status indicating light for use when system is in local control mode.

I. The mechanisms in each basin shall be controlled as a unit independent of any other basin. Each drive mechanism to be furnished with position transmitter to identify continuous location of collection assembly, along with end switches to stop unit at end of travel in each direction.

J. Interlocks shall prevent operation of a sludge collection unit if the other sludge collection unit in the basin is in operation.

K. Frequency of basin cleaning will be regulated by a programmable clock located within the PLC. The PLC shall permit selection of continuous operation via targets from a graphic display in the plant PMCS or a delay at each end of the basin after completion of travel over a cycle of 0 to 168 hours.

L. Control panel to be provided with a single phase power supply under the Electrical Contract. Panels to include line surge protection to protect electronic equipment within from voltage spikes and surges.

M. Control panel shall be factory wired and tested. Provide clearly identified, industrial type terminal strips for all external field connections.

N. Control wiring shall meet the following requirements:
1. Loss of power to a control device shall result in an alarm condition.

N. PANEL FEATURES
1. The control panel shall be provided with the following items and/or features:
   a. Panels shall be constructed of 304 or 316 stainless steel and rated NEMA 4X.
   b. The Control Panel shall contain a fluorescent work light and 15 amp 120 Volt GFI convenience receptacle.
   c. Terminal blocks shall be provided for termination of all "field run" cables.
   d. All PLC inputs and outputs external to the Control Panel shall be wired to fused terminal blocks equal to Allen Bradley 1492-H6.
   e. Terminal blocks for voltage of 120 volts and less shall be equal to Allen Bradley 1492-W10 unless specified otherwise.
   f. All selector switches, pilot lights, push buttons and other devices that are visible on the front of the panels shall have Lamacoid nameplates that are white with black letters.
   g. Long-life LED bulbs shall be provided for all indicating lights.
   h. Route all wiring in Panduit or similar wireways and separate into categories (i.e., 480 volt power, 120 volt control, etc.). AC or DC power wiring shall not run in any raceway with any type instrument signal wiring. Protect all wiring across panel hinges. Provide numbered terminal strips for all field-wiring terminations.
   i. Wiring shall be stranded copper, 600 volt, MTW or THHN insulated, extra flexible type. Install a minimum of #12 AWG for all power wiring, #16 AWG for all control wiring and #18 AWG twisted shielded pair for analog signal conductors. Color code wires as follows:
      1) Ground wiring shall be green.
      2) 120 volt ac, 480 volt ac and 90 volt dc power wiring shall be black.
      3) Neutral wiring shall be white.
      4) 120 volt ac control wiring shall be red.
      5) 24 volt dc control wiring shall be blue.
      6) Wiring within a cabinet, which cannot be de-energized from within the cabinet, shall be yellow.

7) Surge suppression terminal blocks shall be equal to Allen Bradley 1492-WD4SS.
8) Wiring at all terminals within panels, junction boxes, and field devices shall be numbered with shrink fit, machine printed labels.

O. ELECTRICAL COMPONENTS
1. Power Distribution Blocks: Allen Bradley 1492-PD, Square D type LB or Ilsco type PDB.
2. 120 Volt Circuit Breakers: Allen Bradley 1492-CB,
3. Control Relays: Allen Bradley type HA, Potter Brumfield type KRP or Square D type KP.
4. Selectors and Push buttons: 30.5 mm, heavy duty, NEMA 4X rated; contacts rated 10 amps continuous, 6 amps break at 120 VAC, equal to Allen-Bradley Type 800H.
5. Indicating Lights: 30.5 mm, heavy duty, NEMA 4X rated, 6 volt transformer type, equal to Allen-Bradley Type 800H.

P. CONTROL COMPONENTS.
1. A single Bristol Babcock Inc., Control Wave PLC shall be provided to control and monitor the SCS. Provide a minimum of 20 percent spare memory capacity, a minimum of 20 percent spare I/O points, and interposing relays as specified for external status/control signals.
2. Provide complete software documentation including electronic PLC program and ladder logic diagram printout with a complete set of comments and a narrative description of the sequence of operation. The documentation shall be provided to the PMCS programmer for this project to incorporate into the plant-wide PMCS for alarming, and graphic display and report development.

2.07 SPARE PARTS
1. The intent of this Specification is to provide uninterrupted operation for a minimum period of five (5) years. To meet this objective, the manufacturer shall supply any spare parts that are required to meet this time frame.

2.08 WELDING

A. All welding practices shall be in accordance with the requirements of the American Welding Society (AWS) "Welding in Building Construction". All welders shall be certified in accordance with this AWS specification for any welding work performed under this section.

PART 3 EXECUTION

3.01 INSTALLATION

A. The mechanism shall be installed in accordance with the manufacturer's recommendations as approved by the Engineer. Prior to start-up of the sludge

collection mechanism, a field service engineer employed directly by the manufacturer shall inspect the equipment, make necessary final adjustments and certify the equipment ready for operation.

3.02 SERVICE

A. The equipment manufacturer shall provide a factory trained field service representative to inspect the installation and operation of the sludge collection mechanism. In addition, the field service representative shall instruct the owner's personnel in the proper operation and maintenance of the equipment. As a minimum, the manufacturer's field service representative must be available for 2 days of service in 2 separate trips.

3.03 MECHANICAL TESTING AND CERTIFICATION

A. After start-up and prior to final acceptance, the Contractor shall conduct Engineer witnessed performance demonstration tests on the sludge collection mechanism.

B. A field service representative will cause the sludge collection mechanisms to perform all functions that the mechanisms are capable of as defined under this Section and Section 13410 of these Specifications. Tests will be scheduled with the Engineer at least two (2) weeks prior to the planned test date.

C. Inspection by a representative of the manufacturer who is not a direct, full time employee of the manufacturer is not acceptable.

END OF SECTION

SECTION 11228

PLATE SETTLERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Plate settler systems, support systems, and effluent troughs. Requirements are for four (4) complete systems for the Phase 1 construction and one (1) complete system for the Phase 2 construction.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Products: Section 01600.
   3. Alternatives: Section 01100.
   4. Testing: Section 01650.
   5. Basic Equipment Materials and Methods: Section 11005.

1.02 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM A276 - Standard Specifications for Stainless and Heat Resisting Steel Shapes and Bars.
   2. ASTM A167 - Standard Specification for Stainless and Heat Resisting Chromium - Nickel Steel Plate Sheet and Strip.

B. NSF International:
   1. NSF 61, Drinking Water System Components – Health Effects.

C. Occupational Safety and Health Administration (OSHA).

1.03 SYSTEM DESCRIPTION

A. A total of four (4) clarification basins will be equipped with plate settlers in Phase 1 construction and one (1) clarification basin will be equipped with plate settlers in Phase 2 construction.

B. Unit Geometry: Plate settlers shall be designed to operate in a basin 30'-6" wide by 36'-1" long with a 19'-0" side water depth. Provisions are included in the basin layout to allow room for removal of sludge collection equipment through the top of the basin. The plate settlers cannot cover the entire basin.
   1. Locate the plate settlers as close to the effluent end of the sedimentation basins as possible. Arrange plate settlers to maximize the remaining open area at the influent end of sedimentation basin to allow for upgrading the capacity of the basin to 7.5 mgd by the installation of additional plate pack(s).

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C. Plate Settler System: Each plate settler system shall be designed to operate in its basin as shown on the Drawings and as specified below:

Design Criteria (Per Each Clarification Basin)	Units	Maximum	Ultimate
Flow	mgd	6.7	7.5
Effective Hydraulic Surface Loading Rate	gpm/sf	0.45	0.45
Minimum total Horizontally Projected Wetted Plate Area*	sq.ft.	12,860	
Minimum Total Horizontally Projected Wetted Effective Surface Area of Plates**	sq.ft.	10,288	
Plate angle of Inclination from Horizontal	Degrees	55	
Horizontal Plate Spacing (Center to Center)	Inches	2.44	
Perpendicular Plate Spacing (Center to Center)	Inches	2.0	
Wetted Plate Length	Ft.	10	
Plate Width	Ft.	4.5	
Number of Plate Rows	---	5	
Maximum Flow Maldistribution	%	10	
Maximum Velocity Influent Channel	fps	0.40	
Maximum Upflow Velocity between Plates	fps	0.03	
Maximum Velocity through Influent Slots	fps	0.25	
Maximum Velocity in Effluent Channels	fps	2.0	
Water Surface Elevation in Sedimentation Basin	feet	759.0	
Water Surface Elevation in Sedimentation Basin Effluent Flume	feet	758.6	

* Wetted plate area shall be calculated as the horizontally projected area based on the length, width, and angle of inclination of the plates.

** Effective surface area is defined as 80% of the minimum total horizontally projected wetted plate area.

D. Flow Control and Effluent Trough: Provide flow distribution and effluent collection using either outlet tubes with orifices attached to each plate or side mounted V-notch weirs.

1. If top tubes are used, provide flow leveling weirs to maintain water level a minimum of 2-inches above the top tubes under all flow conditions. Provide stainless steel effluent channels between the rows of plates to collect flow from the leveling weirs.
2. If side mounted V-notch weirs are used, position weirs to maintain approximately 4-inches of water above the top of the plates. Baffle plates or orifice plates located directly on top of the plates are not permitted.
3. Provide collection trough at effluent end of sedimentation basin to direct all effluent flow into the sedimentation basin effluent flume. Effluent trough to bolt to wall mounting flange with flexible connection.

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4. If plate settler influent channel is not connected directly to sedimentation basin influent wall, furnish basin with flow infusers to distribute influent flow.
5. The influent/effluent channels and connections shall be designed for thermal and structural expansion and contraction. Each trough shall be designed for a high temperature of 120 degrees Fahrenheit and a low temperature of 25 degrees Fahrenheit. Each assembly will be exposed to ambient temperature when the basins are dewatered and the top portions will be exposed on a continuous basis.
6. The influent/effluent channels shall be designed to withstand 2-inch high wave action created by wind without damage to the troughs and without excessive horizontal deflections.
7. The channels and connections shall be designed to withstand any hydrostatic uplift created when filling the sedimentation basin.
8. Removable stop plates shall be provided in the effluent channel to allow the basin to be isolated from the sedimentation basin effluent flume. Stop plates shall be located as shown on the drawings.
9. The outside wall of the effluent channels shall be designed with a top elevation above the weir elevation. Orifices or skimmer slots shall be provided in the outside wall of the side channels to provide approximately four turnovers of water in the adjacent stagnant zone per day and allow passage of floatable material. Slots to be on upstream side of stop plate.

E. Plate Settlers:
1. Plates to be flat sheets with a smooth surface. Corrugated or embossed sheets will not be acceptable.
2. Stiffen plates at the sides with integral angles to resist deflection and assure flatness. Form angles by bending the sheet steel. Angles mechanically fastened to the plates will not be permitted. Provide side inlet ports in the formed angle.
3. Design plates to be installed individually from above, slide down between, and be supported by the adjacent plates. Design plates to provide uniform spacing between adjacent plates across both the length and width of the plates.
4. Mount plates in the sedimentation basins in a counter flow configuration with the bottom of the plate being extended further downstream than the top of the plate and the angle of inclination back toward the influent end of the sedimentation basin.
5. Plates to be structurally capable of supporting the weight of a 250 pound person, either directly on top of the plates or by placing boards across the tops of the plates. The effluent troughs must be structurally capable of directly supporting the weight of a 250 pound person.

F. Structural Components:
1. It is the responsibility of the plate settler manufacturer to design and furnish all support beams, wall brackets and columns.

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1.04 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01300 and Section 11005, shop drawings for the plate settler equipment demonstrating compliance with these Specifications.

B. Additional Information: In addition to shop drawings specified in Section 01300 and Section 11005, submit the following additional information for approval by the Engineer:
   1. Operating loads at points of supports.

C. Design Calculations: The following design calculations shall be submitted and certified by a licensed professional engineer for approval by the Engineer to substantiate the proposed plate settler design:
   1. Flow velocities throughout unit.
   2. Head loss through unit.
   3. Structural design of influent/effluent channels, plate pack structural members, support beams, wall mounted support brackets, connections and plates.

D. Certifications: The following certifications shall be submitted:
   1. The manufacturer shall provide certification that the grades and standards for all stainless steel used in fabrication of the plate settler system complies with the specifications.

1.05 QUALITY ASSURANCE

A. General: The plate settler equipment to comply with all provisions of Section 11005.

B. Responsibility: To ensure that all the equipment required for the installation of the plate settlers and controls is properly coordinated and will function as a unit in accordance with the intent of these Specifications, the Contractor shall obtain all the equipment specified under this Section from a single supplier in whom the responsibility for the proper function of all the equipment, regardless of manufacturer, as an integrated and coordinated system shall be vested. The intent of this paragraph is to establish unit responsibility for all the equipment with the plate settler equipment supplier. The use of the word "responsibility" relating to the equipment supplier is in no way intended to relieve the Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

C. Basis of Design: Drawings and Specifications are based on Meurer Research, Inc. (MRI) plate settler equipment. Assume responsibility for costs resulting from changes to structure, piping, electrical work, etc., required for Parkson Corporation, EIMCO Water Technologies, or US Filter, in accordance with Section 01100. Submit drawings to Engineer for approval, showing proposed changes in structure, piping, equipment, electrical work, etc.

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D. Installation: Provide factory trained manufacturers representative to supervise installation of the plate settler system.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle the equipment in accordance with Section 01600, the manufacturers recommendations, and as supplemented herein:
   1. Ship equipment in containers preventing damage and distortion of shape of the plate package framing and effluent channels.
   2. Package and ship the plates in such a manner as to protect the stiffener angles and prevent any distortion of the angles or plate flatness.
   3. Store equipment on wood blocking placed on a level surface, suitably covered and protected at all times. Provide sufficient blocking to prevent any distortion of the equipment. No iron or steel equipment or tools shall be allowed in the handling or erection of the equipment.
   4. Store the equipment to prevent corrosion of the stainless steel due to presence of atmospheric or manmade oxidizing materials.

1.07 JOB CONDITIONS

A. The Contractor and manufacturer shall coordinate plate, support, and trough layout with basin geometry.

B. Coordinate plate settler system installation with installation of sludge removal equipment and discharge piping and pipe supports.

C. It is the Contractor's responsibility to comply with any OSHA confined space regulations that may be applicable to the sedimentation basins.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Plate Settler Manufacturers:
   1. Meurer Research, Inc., Golden, Colorado
   2. Parkson Corporation, Fort Lauderdale, Florida
   3. EIMCO Water Technologies, Salt Lake City, UT
   4. US Filter "Zimpro"

2.02 MATERIALS

A. General:
   1. All structural steel shall conform to "Standard Specifications for Structural Steel of the ASTM". Stainless steel shapes and bars shall conform to ASTM A276. Stainless steel plates shall conform to ASTM A167.

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2. All equipment shall be designed for continuous, twenty-four hour operation, and all parts of the system shall be amply proportioned for all stresses which may occur during fabrication, erection, and operation.
3. All metals including plates, shapes and bars, anchor bolts, bolts, nuts and washers shall be 304 or 304L stainless steel and shall be of ample size and strength for the purpose intended. All bolts shall be furnished with the equipment and set by the Contractor in accordance with the manufacturers instructions.

B. Plates: Provide individual settler plates shall fabricated from minimum 24 gage Type 304 or 304 L stainless steel. Top outlet tubes, if used, to be manufactured of Type 304L stainless steel.

C. Effluent Troughs:
1. Provide effluent troughs constructed of Type 304 L stainless steel. Provide lateral stiffness and rigidity through the use of Type 304 stainless steel angles and spreaders placed at strategic locations and shop welded to the troughs.
2. Provide with a Type 304 L stainless steel closure plate on the upstream end of the troughs. Shop weld closure plate to the trough.
3. Provide adapter section to connect effluent trough to sedimentation basin effluent flume.

D. Gaskets:
1. Provide neoprene sponge gasket between effluent trough adapter and trough wall fitting.

E. Metal Attachments:
1. All bolts, nuts and washers, anchors and spreaders shall be Type 304 stainless steel.
2. Anti-seize thread lubricant shall be applied to all bolts. Anti-sieze lubricant shall be NSF 61 certified.

F. All metal surfaces shall be smooth and free of burrs.

G. All arc welds shall be ground smooth and fully passivated. Passivating material shall be NSF 61 certified.

H. All metal surfaces shall be free of rusting.

I. Plate settler framing members, support beams, and wall brackets to be Type 304 stainless steel.

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PART 3 EXECUTION

3.01 INSPECTION

A. Inspect all equipment prior to erection. Repair or replace damaged items as directed by the Engineer, at no additional cost to the Owner. Have only factory-trained manufacturers representative perform repair work.

3.02 INSTALLATION

A. General: Install support beams, plates and effluent troughs in conformance with provisions of Section 11005 of these Specifications, as shown on the Drawings, and in accordance with the manufacturers recommendations.

B. Structural Design: Incorporate approved plate settler support and connection details into the plate settler basin structural construction.

C. Install plate settler system so that the tops of the plates and are level to within +/- 1/8-inch.
   1. If top outlet tubes are used, install flow leveling weirs so that weir edges are level to within +/- 1/32-inch.
   2. If side mounted V-notch weirs are used, level invert of V-notches to within +/- 1/32-inch.

3.03 START-UP

A. Have manufacturers representative check and verify that installation of the plate settler system is in accordance with Drawings and manufacturers installation instructions prior to filling with water.

B. Have manufacturers representative inspect and supervise adjustment of all flow leveling weirs or V-notch weirs, and all effluent troughs.
   1. Demonstrate to the Owner and Engineer that plate installation, flow leveling weirs and effluent troughs are level within above tolerances using laser leveling equipment.

C. Start-up and test in accordance with Section 01650 of these Specifications. Manufacturer shall perform necessary jar tests, establish all chemical feed rates, and flocculation requirements with concurrence by the Owner.

D. Have manufacturer's representative instruct plant personnel on maintenance of plate settlers.

END OF SECTION

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SECTION 11236

ROTARY BLOWER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Rotary positive displacement blower complete with intake air filter, intake air silencer, discharge air silencer, pressure relief valves, relay control panels, and any other accessories, as shown on the Drawings and as specified herein. All equipment to be furnished under Phase 1 construction.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Basic Equipment Materials and Methods: Section 11005.

1.02 REFERENCES

A. Institute of Electrical and Electronic Engineers, (IEEE).

B. National Electrical Manufacturing Association, (NEMA).

C. American Society of Mechanical Engineers, (ASME).

D. Occupational Safety and Health Administration (OSHA).

E. Acoustical Society of America (ASA).

1.03 SYSTEM DESCRIPTION

A. General. All blowers and motors shall be supplied by one manufacturer, and shall be of standard design and construction as fabricated, assembled, and tested by the manufacturer.

B. The blowers and motors shall meet the design ratings and conditions listed below.
   1. Blower Design Ratings:
      a. Number of Units: 1 (space allocated for future blower)
      b. Inlet Capacity (at blower inlet flange): 1600 ICFM.
      c. Inlet Temperature (degrees F): 70 degrees.
      d. Inlet Pressure: 14.56 PSIA.
      e. Discharge Pressure: 6.5 PSIG.
      f. Connections:
         1) Inlet: 8 FLG.
         2) Outlet: 8 FLG.
   2. Motor:
      a. Enclosure: TEFC.
      b. Horsepower: 60 HP.

c. Voltage, phase, hertz: 460, 3, 60.
d. Nominal Speed: 1800 rpm.

3. Acoustic Performance: Blower and motor noise with sound attenuating lagging Lon silencer, and with inlet and discharge piped away and a sound attenuating enclosure shall not exceed the average sound pressure level listed below (measured under "free field" conditions at a distance of one meter). Average sound pressure levels shall be based on a weighted average of at least nine separate frequencies between 31.5 and 8000 hertz If the sound pressure levels cannot be met, the blower manufacturer shall be responsible for providing sound attenuation to meet the below listed criteria.
   a. Average Sound Pressure: 80-85 dBA.

1.04 SUBMITTALS

A. Submit in accordance with Section 01330, Shop Drawings for the equipment demonstrating compliance with these Specifications including:
   1. Manufacturers literature, illustrations, specifications and engineering data defining materials of construction, dimensions, weights, and blower and motor performance, and recommendations on length and diameter of anchor bolts.
   2. Parts list.
   3. Manufacturers Certified test data curves and results of acoustic testing.

1.05 QUALITY ASSURANCE

A. General: The blower equipment shall comply with all provisions of Section 11005.

B. Contractor Requirements: Refer to Section 11005.

C. Manufacturers Experience. Refer to Section 11005 for experience requirements of the manufacturer.

D. Shop Testing.
   1. Test each blower at the manufacturers shop or pre-qualified authorized distributor with the job motor or an approved shop drive.
   2. Tests shall include slip, mechanical, and flow tests. Test each blower for slip. Test one blower mechanically and for flow tests.
      a. Mechanical Test. Run blower for one hour at specified rating.
      b. Flow Test. One point flow test at specified ratings.
   3. Performance shall be within the following tolerances as follows as long as the motor does not exceed the nominal motor rating.
      a. Specified Capacity: Plus 4 percent at specified conditions herein.
   4. Conduct shop tests in accordance with ASME Power Code requirements except as modified herein.
   5. Conduct shop tests to verify "free field" sound pressure levels in compliance with the Specifications.
   6. Submit certified test data for approval in accordance with Section 01300.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Storage:
   1. The Contractor shall schedule delivery. If off site storage is required for long term storage, then it shall be a bonded storage facility under the control of the Contractor. Contractor should include this cost in lump sum proposal. The General Contractor shall be responsible for rotating the equipment and performing all required preventative maintenance during long term storage.
   2. The blower equipment should be installed as received. If partial disassembly is necessary the Contractor shall contact the Equipment Manufacturer for instructions prior to disassembly.
   3. The manufacturers instructions for handling and installing the equipment shall be followed. All piping and electrical connection shall be made as indicated on the Drawings, and as recommended by the Manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Roots Division, Dresser Industries.
   2. Champion

2.02 MATERIALS

A. General:
   1. All bolts and nuts shall have hexagon heads.
   2. Type 304 stainless steel anchor bolts shall be furnished by the manufacturer.
   3. Each blower shall be furnished with a stainless steel data plate securely attached to the unit. Data plates shall contain the manufacturer's name, blower size and type, serial number, speed, capacity, and other pertinent data.

B. Blower:
   1. Shall be heavy duty rotary positive blowers designed with rugged cast iron mounting feet vertical installation and air flow.
   2. Shall consist of a cast iron casing, alloy steel gears, steel shaft, cast iron involute impellers, anti-friction single row cylindrical roller bearings on gear diameters below 10", anti-friction double row spherical roller bearings on gear diameters 10" and above, and splash lubed. Grease lubrication is not acceptable. A double sealing arrangement shall be provided to prevent lubricant from contaminating the air stream.
   3. The blowers shall be shipped with openings sealed after injection of rust inhibiting powder.
   4. The blowers shall be given a mechanical test by the factory or factory pre-qualified packager to assure mechanical integrity and conformance with requirements specified hereinabove. If tests indicate adjustments are required to meet specifications, such adjustments shall be made prior to shipment.

5. The blower shall be V-belt driven and supplied with a suitable guard meeting OSHA specifications.

C. Electric Motor:
   1. Type: The motor shall be horizontal, induction type motor.
   2. Standards: The motor shall conform to NEMA Standards, applicable IEEE Standards
   3. Warranty: The motor shall be free of defects in material and workmanship, and shall be guaranteed to operate satisfactorily under proper application for one year from date of shipment.
   4. Design Characteristics: The motor shall have the following minimum characteristics:
      a. 3-phase, 60 cycle.
      b. NEMA Design B.
      c. Normal starting torque.
      d. Class F insulation.
      e. 40 degrees C ambient.
      f. Suitable for frame mounting.
      g. Service factor = 1.15.
   5. Frame: The motor frame shall be corrosion-resistant cast iron or cast steel. The mounting ring, unless otherwise approved, shall be built integral with the frame.
   6. Bearings and Lubrication: The ball bearings shall be double shielded, grease lubricated, single row width and made from vacuum degassed steel. The bearings shall be grease lubricated with readily accessible inlet and outlet plugs or fittings to allow for changing the grease.
   7. Conduit Box and Leads: The conduit box shall be diagonally split and rotatable in 90 degree steps and shall be provided with knockouts. A gasket shall be furnished between the conduit box and frame. Leads shall be stranded wire, suitably insulated and permanently identified with crimp-on solderless connectors.
   8. Hardware: Nameplates shall be stainless steel with embossed or preprinted lettering and shall be fastened to the motor frame with corrosion resistant pins. All bolts and cap screws shall be of high strength, zinc-plated and chromated steel. Nameplate data shall include manufacturer's name, pump number, phase, horsepower, rpm, ampere and volt ratings, efficiency, power factor, enclosure, insulation and frame size.
   9. Manufacturer: Blower motors shall be as manufactured by one of the following:
      a. U.S. Electrical Motors.
      b. General Electric Company.
      c. Reliance.

D. Inlet Air Filter: The filter shall be the dry type, pleated paper element filter contained in a weather protected housing. The filtering shall provide oil-free and fine degree of filtration. Filter removal efficiency shall be at least 99.5% with particles 2 microns in diameter and larger and 97% with particles 1 microns in diameter and larger. The filter shall be Universal CCF Filter.

E. Inlet Silencer: Silencer shall be of the chamber absorptive type, interconnected by perforated tubes and tuned to subdue flow pulsations in a broad frequency range (50-8000 Hz). The silencers shall be provided with flange ends on both the inlet and outlet ends as shown on the drawings. The silencers shall be Universal Silencer RIS-Y designed with saddles horizontal table top frame mounting. Provide shell lagging as specified herein.

F. Discharge Silencer: Silencers shall be of the chamber absorptive type, interconnected by perforated tubes and tuned to subdue flow pulsations in a broad frequency range (50-8000 Hz). The silencers shall be provided with flange ends on both inlet and outlet ends. The silencers shall be Universal Silencer SD-Y with saddles for horizontal mounting in a table top frame configuration. Provide shell lagging as specified herein.

G. Relief Valve: Pressure relief valve shall be 4 inch non-vibrating, spring type. The pressure relief shall be Kunkle 337 spring type with flange connections to match discharge piping. Valve to be factory set at 8.0 psi.

H. Flexible Coupling: Flexible couplings shall be furnished and installed on the blower discharge and the blower intake. Provide Flex Fab Series 500 type.

I. Discharge Pressure Gauge: Provide pipe mounted discharge pressure gauge equivalent to U.S. Gauge, McDaniel Instruments. Gauge to be mounted on pressure switch assembly. Provide tap on spool piece upstream of check and relief valve.
   1. Range: 0-15 psig.
   2. Accuracy: 1 percent of full scale.
   3. Dial: 4½", 270 degree scale.
   4. Case: Aluminum, front flanged.
   5. Connection: ¼ inch NPT back connection.
   6. Liquid Filling: Glycerin.

J. Inlet Differential Gauge: Provide a differential pressure gauge and switch for blower inlet filter package supplied. Gauge / switch to be wall mounted and shall monitor differential pressure across the inlet filter. Gauge shall be Dwyer Model No. A3020. Capacity shall be 0 - 20 inch Water column. Furnish in NEMA 12 enclosure with fittings to pipe as required.

K. Mounting baseplate and frame: The blower and motor shall be mounted on a one piece heavy duty machined base plate and the entire blower assembly shall be mounted on a heavy steel welded equipment frame as shown on the Drawings. Bolted construction is not acceptable. Anti vibration welded reinforcements shall be provided.
   1. Provide lifting lugs or forklift access to permit balanced lifting of entire assembly with all equipment mounted. Provide prominent markings of all access or lift points.
   2. Provide type 304 stainless steel anchor bolts for connection of frame to concrete equipment pad.

L. Sound Attenuation: Inlet and discharge silencers to be provided with shell lagging of high density, long strand, high temperature fiberglass matting compressed and retained within a heavy gauge steel covering.

M. Check Valve: Provide double door flanged wafer body check valve with cast iron body, aluminum internals and silicone seat as manufactured by Techno Check.

N. Manufacturing Nameplate: Provide a stainless steel nameplate securely fixed to each blower assembly which indicates manufacturer, serial number, model number, related pressure and air capacity, and impeller size and speed.

O. Spare Parts:
   1. Contractor shall deliver the following spare parts for each size blower:
      a. One (1) set of seals.
      b. One (1) set of gaskets.
      c. One (1) set of V-belts.
      d. Four (4) filter elements.
      e. Two (2) cases of blower oil..

P. Sound Attenuating Enclosure:
   1. Provide 5-sided sound attenuating enclosure with removable panels for access to blower for maintenance.
      a. Manufacturer:
         1) West Chester Manufacturing.
   2. Provide tight fitting perimeter envelope design with minimum 2-inches clearance between enclosure and equipment at all points.
   3. Enclosure to be factory assembled and skidded.
   4. Frame constructed of heavy aluminum square tubing.
   5. Panels constructed of minimum 18 gage galvanized steel exterior and minimum 22-gage perforated interior. Provide 2-inch thick flame resistant sound absorption material with minimum density of 6lbs/cu. ft. Material to be bagged in 2-mil polyethylene bag. All edges of bag to be heat sealed.
   6. Finish paint to be two component catalyzed polyurethane.
   7. Provide acoustic seal strips around all sides of doors and removable panels.
   8. Provide ½ HP fan and baffled air vents for positive ventilation of enclosure. Size fan to maintain temperature differential between interior and exterior at less than 25 degrees F.

PART 3 EXECUTION

3.01 START-UP AND TESTING

A. Manufacturers authorized representative to check and approve the installation prior to initial start-up and provide installation certificate prior to initial start-up.

B. Field Testing. Run blowers in the field, Contractor Manufacturers Representative and Engineer to verify operation under field conditions. Measurements to be taken by the Manufacturers Representative to verify the sound pressure levels, capacity, efficiency,

and horsepower of the blowers and to determine that the blower units will operate satisfactorily as specified without overheating or overloading the motor.

Correct all deficiencies to the satisfaction of the Engineer.

C. Factory-trained and certified manufacturers representative to instruct plant personnel on repair and maintenance of the blower units and provide certification of training. For specific requirements refer to Section 11005 Part 3.

END OF SECTION

SECTION 11241

VOLUMETRIC CHEMICAL FEED EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of one (1) volumetric feeder to feed dry potassium permanganate and one (1) volumetric feeder to feed dry powdered activated carbon. All equipment and systems to be furnished for the Phase 1 construction.

B. Related Sections:
   1. Testing: Section 01600.
   2. Paints and Coatings: Section 09900.
   3. Basic Equipment Materials and Methods: Section 11005.
   4. Basic Measurement and Control Instrumentation Materials and Methods: Section 13410.

1.02 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA Standards Publications.

1.03 SYSTEM DESCRIPTION

A. General: Each volumetric chemical feed system shall consist of the following equipment:
   1. Powdered Activated Carbon System.
      a. Volumetric dry feeder with motor and controls.
      b. Dissolver with mixer.
      c. Adapter Plate.
      d. Flexible Connector.
      e. Hopper mounted bulk bag loader with loading hatch.
      f. Storage hopper with vibrator and low bin alarm.
      g. All piping and wiring to make a complete and satisfactory installation.
   2. Potassium Permanganate System.
      a. Volumetric dry feeder with controls.
      b. Dissolver tank with mixer. Float valve and level switch.
      c. Drum Inverter: (1)
      d. Transfer Pumps: (1) furnished under this Section
         (2) shall be provided under Section 11216.
      e. Drum funnel with shutoff valve.

f. System power and control panel.
g. All piping and wiring to make or complete a satisfactory installation.

Each system shall function as a unit to deliver the chemical in conformance with the Drawings and as specified.

B. Design Specifications: the following schedule of volumetric chemical feed equipment shall be furnished and installed. Model numbers refer to Acrison (Carbon) and Carus Chemical Company (Potassium Permanganate) dry feeders, and Pennberthy Eductors.

Volumetric Chemical Feed Equipment Design Criteria			
		Powdered Activated Carbon	Potassium Permanganate
A.	No. of Systems	1	1
B.	Operation	SCR	SCR
C.	Dry Feeder Schedule		
	1. Helix Size (in.)	1 1/2"	1 1/2"
	2. Maximum Feed Rate (CFH)	21.72	0.29
	3. Minimum Feed Rate (CFH)	0.12	0.15
	4. Manufacturer/Model No.	Acrison/W105Z	Carus/CXF-1000
D.	Adaptor Plate	Required	Required
	1. Flexible Connector	Required	Not Required
	2. Bag Loader	Required	Drum Inverter
E.	Dissolver Schedule		
	1. Minimum Capacity (gal.)	100	50
	2. Material of Construction	Stainless Steel	Stainless Steel
	3. Type of Agitation	Mech. Mixer w/Vortex Wetting Eductor	Mech. Mixer
F.	Eductor (PVC)	1 ¼-LH	¾-HL
G.	Floor Stand Capacity (lbs.)	3000	330
H.	Dust Collector w/Filters	Not Required	Not Required

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with Section 01300 and Section 11005, demonstrating compliance with specifications.

B. Furnish written installation, operation, and maintenance instructions.

1.05 QUALITY ASSURANCE

A. General Requirements: Comply with all provisions of Section 11005 – Basic Equipment Materials and Methods.

B. Responsibility: to ensure that all equipment required for installation of volumetric chemical feed and transfer equipment and controls is properly coordinated and will function in accordance with intent of these Specifications, obtain all equipment specified under this Section from a single supplier. Supplier vested with responsibility for proper function of all equipment, regardless of manufacturer, as an integrated and coordinated system. Intent of this paragraph is to establish unit responsibility for all equipment with volumetric chemical feed equipment supplier. Use of word "responsibility" relating to volumetric chemical feed equipment supplier is in no way intended to relieve Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

C. Welding to conform to standards of American Welding Society.

D. Steel design to conform to American Institute of Steel Construction.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Deliver, store and handle equipment in accordance with these specifications and manufacturer's instructions.

B. See Section 1600 for general handling, storage and protection requirements.

1.07 PROJECT CONDITIONS

A. Electrical Interface:
   1. Wiring: Wiring to and from starters, switches, relays and contacts performed as work of Division 16, unless otherwise specified. Feed Equipment supplier to furnish all starters, switches, relays, and contacts, specified in this section.

B. Coordinate with requirements of Section 13410: Basic Measurement and Control Instrumentation Materials and Methods.

C. Carbon System: All electrical components to be located in the Carbon Feed Room and Carbon Storage Room shall be explosion-proof.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Acrison, Inc.
   2. Carus Chemical Company
   3. Wallace & Teirnan
   4. Merrick Industries, Inc.

2.02 MATERIALS

A. General:
   1. Materials used in volumetric chemical feed systems shall be inert and resistant to deterioration or corrosion from the chemicals that they are designed to handle.
   2. Parts which contact the chemicals shall be stainless steel, fiberglass or Buna N except as noted herein.
   3. The interior of the feeders that are not stainless steel and that are exposed to the humid conditions from the dissolver shall be painted with a corrosion-resistant epoxy paint.

2.03 COMPONENTS

A. Volumetric Dry Feeders:
   1. General: Each feeder to deliver chemical within ±1 percent by volume of set rate over a 20:1 range. Feed rate set either manually by a rate control potentiometer or automatically in proportion to a 4-20 mA pacing signal. The feeders shall be suitable for changing the belt and feed screws in the field to increase or decrease feed rate, as shown in the schedule. Any other parts necessary for operating feeder at rates indicated under Paragraph 1.03.B - Performance Requirements mounted on feeder, so that all that is necessary for plant operator to do is replace helix. The screws and bolts of each feeder shall be interchangeable with any other feeder of the same make and model.
   2. Materials: The feeder housing shall not be less than 14-gauge steel, surface ground bonderized after fabrication, filled, primed and finished with corrosion-resistant enamel paint. The inner hopper of the carbon feeder shall be stainless steel. Each feeder helix and discharge sprout shall be 316 stainless steel

3. Motors and Drives:
   a. 1/4 hp controlled by an SCR variable speed drive. 115 volt, 60 hertz, 1 phase power supply.
   b. Motor shall operate on a direct current and have a Class II rating.
4. Control Panels: Feeder manufacturer to furnish a control panel for each feeder.
   a. NEMA 12 panel enclosures remote wall mounted. Carbon feeder assembly to be NEMA 9 rated enclosure with remote wall mounted NEMA 12 control panel. Following housed in each panel:
      1) SCR drive with isolator.
      2) Mixer motor starter and disconnect (remote mounted in control panel).
      3) Hopper Vibrator controller, starter and disconnect for remote start (Carbon only).
      4) Termination block and circuit breakers for distribution of power.
      5) Dry contacts to provide status output for feeder power on and mixer fail condition to DCS system.
      6) Control panel contact to provide low hopper level alarm output to SCADA system.
      7) Disconnect switch and control circuit fuses.
      8) Local/Remote switch for feed rate adjustment.
   b. Following contained on face of each panel:
      1) Manual speed control potentiometer
      2) Indicator to show percent of full speed in both manual and automatic modes
      3) Dosage control potentiometer
      4) Feeder running lights - "ON" (Red) and "OFF" (Green).
      5) Mixer ON/OFF switch
      6) Mixer Running light - "ON" (Red) and "OFF" (Green).
      7) Feeder Control selector switch (Hand/Off/Automatic)
      8) Local/Remote Switch with remote status contact (for speed control).
      9) Hopper vibrator selector switch (Hand/Off/Automatic)
      10) Low bin level alarm light (Red).
      11) Mixer trouble light (Red).
      12) Timer controls for interval/duration timer.
      13) Master disconnect switch.
   c. Panel wired such that if mixer fails, feeder will shut down and an alarm will be generated for output to SCADA system.
   d. When hopper vibrator selector switch is in Auto position, vibrator operation tied into operation of feeder, such that when feeder starts, controls are reset and vibrator starts. Controls for vibrator include interval and duration timers. When feeder is not running, vibrator's automatic controls disabled. In manual mode, vibrator to run based on interval/duration timer.

e. Installation of lime and carbon feeder wiring between control panel, feeder, mixer, and vibrator performed in field as work of Division 16.

5. Feeder Hopper Agitator: Inner hoppers of each feeder provided with a positive action, oscillating diaphragm type agitator to prevent arching and packing of chemical.
   a. Integral part of feeder and separate from hopper vibrator.
6. Each feeder provided with a flexible connection

B. Dissolvers (Slurry Tank):
1. General: Each feeder to feed into a dissolver of type and size specified in design criteria. Each dissolver to have water inlet, discharge, overflow and drain connections located in strict accordance with Drawings. Inlet piping with float valve to maintain a constant water level. Dissolvers equipped with jet agitators piped so that supply water is introduced thru jet agitator. Float valve not to obstruct free fall of chemical into dissolver. An inner baffle provided with each dissolver to prohibit short-circuiting of chemical to outlet. A cover with hinged inspection plate provided on each dissolver. Carbon dissolver fitted with vortex eductor system suitable for wetting carbon prior to entry into dissolver. Water supply controlled by solenoid valve furnished under Section 13410.
2. Connections: Bulkhead type fittings suitable for connecting copper and PVC pipe of sizes shown on Drawings provided for all inlets, outlets, overflows and drains. Provide flanged connections for level probes furnished under Section 13410.

C. Mixers: Each dissolver furnished with a mechanical mixer rigidly installed to keep chemical suspended in solution.
1. Shaft and impellers: 316 stainless steel.
2. Mechanical mixer motors:
   a. Totally enclosed, fan cooled, chemical duty.
   b. Class B insulation
   c. Minimum horsepower rating: 1/4. Carbon mixer motor to be dust-ignition proof. (Explosion proof).
   d. Power supply: 115-volt, one phase, 60 hertz
3. Motor starters with overload protection furnished and installed in control panel.

D. Transfer Pumps
1. General: Provide centrifugal pump for Potassium Permanganate volumetric feed system to transfer treatment chemicals from dissolver to batch tank and batch tank to day tank (Specification Section 11216) as shown on Drawings and specified herein. Treatment chemicals to be transferred include the following:
   a. Potassium Permanganate

2. Design Requirements:

a. Quantity: 1
b. Capacity: 25gpm
c. TDH: 15 feet
d. Motor Requirements: 480 volt, 3 ph, 60 Hz.

E. Batch Tank:
1. General: Provide a cross linked High Density Polyethylene agitated storage tank as shown on Drawings and specified herein to store and keep the solution well-mixed prior to use. Treatment chemicals to be stored:
   a. Potassium Permanganate.
2. Design Requirements:
   a. Storage Capacity: 550 gallons
   b. Max. Diameter: 64 inches
   c. Max. Sidewall Height: 60 inches
   d. Provide threaded bulkhead type fittings for agitated mixer, instrumentation, and all fittings and vents as indicated on the Drawings.
3. Mixer
   a. General: Provide one (1) top entering mixer assembly with 3-blade, square pitch propellers. All wetted parts shall be 316 stainless steel. The size and length of shafts, impeller diameters and numbers of impellers and their locations for the chemicals and size of batch tank specified, shall be established by the mixer manufacturer and submitted to the Engineer for approval. The shaft length shall have an adequate allowance for mixer mounting distance above the batch tank. The manufacturer shall verify that the specified wetted parts are suitable for the proposed chemical.
   b. Speed: 350 RPM Constant Speed
   c. Min. hp: 3/4
   d. Motor: Motor shall have a service factor of 1.15 and be suitable for 120-volt, 1-phase, 60-hertz power. It shall be totally enclosed fan cooled, chemically duty with Class B insulation. The total temperature rise shall not exceed the temperature standard for Class B insulation when operating at a maximum ambient temperature of 40° C. Starters for the mixer motors will be furnished and installed under Electrical Contract as work of Division 16 - Electrical. Provide power cord with a suitable plug.

F. Mobile Drum Handling and Inverting System
1. Drum Inverter shall be self contained chemical drum-lifting, inversion and handling system. The system shall allow the virtually dust-free transfer of Potassium Permanganate from a 330 lbs. (net wt.) container to the feeder.
2. Drum Inverter shall be supported by two fixed and two swivel wheels and be powered by a 12 Volt battery for easy mobility.

3. Drum Inverter shall be constructed of painted mild steel. The hydraulic system shall utilize a non-combustion promoting type fluid. Feeder adapter shall be acrylic enamel coated carbon steel with a urethane dust seal.
4. Transition hopper shall be stainless steel with iris type flow control/shutoff valve.
5. Drum Inverter shall be equipped with integral 12 volt battery charger and shall plug into standard grounded outlet.

G. Storage Hopper:
1. General: Volumetric dry feeder manufacturer to furnish storage hopper as indicated in Design Criteria. Hopper material as indicated in Design Criteria. Connecting hardware, and interior removable loading screen of 316 stainless steel. Interior removable loading screen to be one-inch wire mesh capable of preventing passage of foreign materials and large agglomerates.
2. Hopper: Hopper feeder supported or self supported from floor as indicated in Design Criteria. Hoppers to include converging hopper with handwheel operated bin gate; top fill connection for flexible screw conveyor; support brackets for screw conveyor; probe connections; and support legs with baseplates to match load cells furnished under Section 13410 as indicated on the drawings.
3. Vibrator:
   a. Pneumatic: Provide two VIBCO explosion proof pneumatic vibrators. Vibrators to be sized by manufacturer for this application. Provide field adjustable interval and duration timers. Interval adjustable between 0 and 10 minutes. Vibrator controllers to be mounted in carbon feeder control panel. Controls to be suitable for 120-volt, single phase, 60 hertz power supply.
   b. Electromagnetic: Hoppers to be supplied with two (2) Syntron Company, V20 electromagnetic vibrators and controllers incorporating field adjustable interval and duration timers. Interval adjustable between 0 and 10 minutes. Duration adjustable between 0 and 1 minute. Vibrator mounted on converging hopper. Vibrator controller mounted in control panel. Vibrator and controller power supply to be 120-volt, single phase, 60 hertz.
4. Alarm Switches: Provide three (3) diaphragm type alarm switches to sense and indicate high, mid, and low level on hopper to generate an alarm signals. Wiring from alarm switch by Division 16. Switch capable of operating at a minimum density of 10 pounds per cubic foot.

2.04 FINISHES

A. Painting: Shop sandblast all ferrous metal surfaces. Shop prime and finish coat in accordance with Section 09900.

2.05 SPARE PARTS

A. Two preventative maintenance kits for volumetric feeder.

B. Provide spare helix for each volumetric feeder, as indicated in Article 1.03.B.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install volumetric chemical feed and transfer system equipment in conformance with provisions of Section 11005 of these Specifications, manufacturer's recommendations, and as shown on Drawings.

3.02 PAINTING

A. Field touch-up as required and approved in accordance with Section 09900.

3.03 FIELD QUALITY CONTROL

A. Site Tests:
   1. Manufacturers representative to check and verify that installation of equipment is in accordance with Drawings and manufacturer's installation instructions prior to starting equipment, and provide installation certificate.
   2. Start-up and test in accordance with Section 01650 of these Specifications.
   3. Test feed systems in presence of Engineer to determine that equipment delivers chemicals within specified accuracy over range of feeder. Test a minimum of four set feed rates. Run each test for at least 10 minutes. Make adjustments while test is in progress. Make adjustments, modifications, or equipment changes as may be necessary to meet specified standards. Make required adjustments and run new tests until equipment meets Specifications, in event equipment fails to deliver ±1 percent of calculated feed rate at test points.

B. Manufacturers Field Services:
   1. Provide factory trained manufacturer's representative for a minimum of number of days indicated in Section 11005 to assist in supervising equipment installation and coordination of all start-up with SCADA system control supplier.
   2. Start-Up: Provide a fully qualified manufacturers service engineer to inspect completed installation, start equipment and place in operation and train operators in its use and care. Service engineer to be a direct employee of equipment manufacturer. Provide services in accordance with the time requirements indicated in Section 11005.

END OF SECTION

SECTION 11243

LIQUID POLYMER FEED EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of polymer feed units and accessories as indicated on Drawings and specified herein. All equipment, systems and accessories to be furnished as part of Phase 1 construction.

B. Related Sections:
1. Submittals: Section 01300
2. Products: Section 01600
3. Testing: Section 01650.
4. Basic Equipment Materials and Methods: Section 11005.
5. Basic Measurement and Control Instrumentation Materials & Methods: Section 13410.
6. Division 16 – Electrical.

1.02 SYSTEM DESCRIPTION

A. Design Criteria:
1. Polymer Feed Units: Provide following polymer feed units. All Model Numbers refer to Polyblend polymer feed units, as manufactured by Stranco, Inc. Polymer feed units to consist of following:
   a. Polymer feed pump (diaphragm metering pump)
   b. Feed pump controller
   c. Mixing chamber with mechanical mixer
   d. Dilution Water Rotameter
   e. Water supply solenoid valve

Quantity	Chemical Pumped	Stranco Model No.	Polymer Feed Pump Capacity (gph)	Total Dilution Water Capacity (gph)
6*	Filter Aid, Coagulant Aid, Wastewater Solution or Emulsion Polymer	PB-100-1 **(Unit A)**	0 to 1.0	100
3	Thickened Sludge	M2400-D10AA **(Unit B)**	0.1 to 10	120-2400

* One unit to be placed in storage

B. Accessories:
   1. Provide following accessories with each feed pump head. Applicable sizes and arrangements as shown on Drawings:
      a. Flexible suction and discharge tubing with clamps
      b. Poppet-type sight flow indicator
      c. Digital display pump controller
      d. Adapters
      e. Spare gaskets
   2. Provide following accessories with each Unit A polymer feed system:
      a. Mounting plate with stainless wall mounting bracket. (Each unit).
      b. Calibration kit (500 ml.)
      c. Drumstick
      d. Drumstir
   3. Provide following accessories with each Unit B polymer feed system:
      a. Polymer units shall be skid mounted, with interconnecting piping and wiring complete within skid limits.
      b. Calibration kit assembly, Model K2342014
      c. Pressure reducing valve
      d. Thermal flow switches

1.03 SUBMITTALS

A. Shop Drawings: Submit shop drawings for equipment in accordance with Specifications and Section 11005, demonstrating compliance with Specifications.

B. Certificates: Submit Manufacturers certificate that polymer feed pumps and accessories are suitable for continuous contact with intended chemical without defects.

C. Submit written installation, operation, and maintenance instructions.

1.04 QUALITY ASSURANCE

A. General: Comply with all provisions of Section 11005 - General Equipment Requirements.

B. Basis of Design: Specifications are based on Stranco polymer feed units. Bear any costs resulting from changes to structure, piping, electrical work, plumbing work, etc., required for Wallace & Tiernan or Fluid Dynamics equipment in accordance with Specifications. Submit drawings to Engineer for approval, showing changes in equipment, piping, structure, electrical work and plumbing work.

C. Responsibility: To ensure that all equipment required for installation of feed unit equipment and controls is properly coordinated and will function in accordance with intent of Specifications, obtain all equipment specified under this Section from a single supplier vested with responsibility for proper function of all equipment, regardless of manufacturer, as an integrated and coordinated system. Intent of this paragraph is to establish unit responsibility for all equipment with polymer pump

equipment supplier. Use of word "responsibility" relating to polymer unit equipment supplier is in no way intended to relieve Contractor's ultimate responsibility for equipment coordination, installation, operation, and guarantee.

1.05 PROJECT CONDITIONS

A. Perform power and control wiring as work of Electrical Contract under Division 16.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer:
   1. Stranco, Inc.
   2. Wallace & Tiernan.
   3. Fluid Dynamics

2.02 MATERIALS

A. General: Furnish polymer feed units and accessories as shown on Drawings and specified herein. Each unit capable of pumping indicated liquid over range shown. Manufacturer responsible for providing materials and head arrangement most compatible with chemical being used.

B. Polymer Feed System – Unit A: Automatic polymer dilution/feed system to consist of an integrated equipment package capable of automatically metering, diluting, activating and feeding liquid polymer and water. System to activate concentrated polymer in a two-stage continuous process within a single vessel. First stage to consist of a turbine mixer to impart high energy mixing. Second stage mixing provided by a low energy turbine mixer. Mixer motor to be 1/6 horsepower, TEFC, continuous duty. Activation chamber suitable for 100 psi working pressure.
   1. Metering Pump: Diaphragm-type metering pump with variable stroke frequency and stroke length, capable of pumping solution-type or emulsion-type polymers with apparent viscosities of up to 45,000 cps. Controlled by means of a remote control module with digital display of pump output in strokes per minute or strokes per hour.
   2. Dilution Water: Provide solenoid valve for on/off control of dilution water supply and rotameter flow indicators equipped with rate adjusting valves to control water to two separate stages of dilution. After stock polymer solution and dilution water have been combined, pass through a static mixer for full blending of two streams.
   3. Flow Sensor: Loss of flow sensor to turn off polymer feed pump if water flow is interrupted for any reason. Restart pump automatically when water flow is restored.
   4. Side frames of 304 stainless steel with baseplate of PVC. Mixing chamber of clear acrylic with PVC end caps. Stainless steel impeller and shaft. Double sealed bearings.
   5. Electrical: Feed pump and mixer suitable for 120 volt, 60 hertz power supply controlled by a single Hand / Off / Remote switch with remote contact to

SCADA. Pacing signal to be 4-20 mA, proportional to flow. Coordinate with Section 13410 requirements.

6. Control Panels:
   a. Control panel for each feed unit to be a wall-mounted NEMA 12 enclosure including, but not limited to, Hand-Off-Remote switch, running light, and disconnect switch. Each control panel provided with a contact for use in generating a feeder running status signal. In "Remote" position, unit will be started and stopped from SCADA system.
   b. Metering pump provided with a remote electronic module mounted on polymer feed unit capable of accepting a 4-20 mA pacing signal for use in adjusting feed rates in proportion to flow. Module to include a Local/Remote switch, a digital display showing pump stroke speed, a rate set knob to manually adjust pump stroke speed and a running light.
   c. Coordinate with requirements of Specification Section 13410.

C. Polymer Feed System – Unit B
   1. Multi-Zone Mixing Chamber
      a. Polymer and water shall be mixed in a chamber designed to create sufficient mixing energy.
         1) This design shall include a motor-driven impeller that will create high fluid sheer.
         2) Solution shall undergo a tapered mixing intensity slope as it exits the initial high sheer zone and passes through a second low shear zone, isolated by a baffle.
         3) Polymer activation efficiency shall be consistent over the dilution water range.
      b. Mixing chamber shall be transparent to allow viewing of mixing intensity. Opaque mixing chambers shall be unacceptable.
      c. Impeller shall be driven by a 1 HP maximum washdown duty motor.
         1) Motor shall be TEFC.
         2) Impeller speed shall be 3450 rpm, minimum.
         3) Motor shall be direct-coupled to impeller shaft.
      d. Mixing chamber shall include a stainless steel injection check valve.
   2. Dilution Water Control
      a. Dilution water shall be split into two streams. Primary water flow shall supply the mixing chamber.
         1) Secondary water flow shall be used to post dilute the activated polymer stream.
         2) These two streams shall be completely blended by a static mixer prior to exiting the unit.
      b. Unit shall have an electric solenoid valve for on/off control of total dilution water flow.
      c. Flow indicators and flow control valves shall be provided for each dilution water stream.
      d. Dilution water and solution output connections shall include 304 stainless steel unions connected to the chassis.
   3. Pump

a. Unit shall have a neat polymer metering pump.
   1) Pump shall be positive displacement, diaphragm type.
   2) Polymer pump head shall be fabricated of clear acrylic and shall have a priming port.
   3) A thermal flow switch shall be supplied in the pump discharge line to detect flow.

4. Controls
   a. Unit shall be controlled through an on-off-remote circuit controlled by a three-position switch.
      1) In the remote switch position, the unit shall accept a run signal.
      2) Unit is manually controlled in the on position.
   b. Unit shall accept a 4-20 mA analog signal to pace the polymer metering pump.
      1) This signal shall be processed by a pump controller that may be mounted remotely.
      2) The controller shall have an LCD readout of pumping strokes per minute (or hour), a stroke frequency touchpad pump control and a mode touchpad (internal-off-external) for pacing signal selection.
   c. Unit shall detect loss of water flow, sensing that water flow has been interrupted for any reason, will place the polymer pump and mix chamber on standby and will restart it automatically when flow is restored.
   d. An integral timer shall monitor loss of flow and energize contacts indicating alarm after 15 seconds of continuous loss.
5. Connections – Plumbing
   a. Dilution water inlet, 1½" FNPT
   b. Neat polymer inlet, ½" FNPT
   c. Solution discharge, 1½" FNPT
6. Connections – Electrical
   a. Standard, grounded male plug – 120 / 1/ 60, 20 amps
   b. Plug in connection – 4-20 mA signal input
   c. Terminal blocks – dry contact input for remote start
   d. Terminal blocks – dry contact alarm output
   e. Terminal blocks – dry contact run output
   f. Terminal blocks – control switch status output
   g. Terminal blocks – loss of polymer flow output
7. Dimensions
   a. Frame – 36" wide x 20" deep x 40" high (92x41x102 cm)

8. Materials of Construction
   a. Structural frame – 304 stainless steel
   b. Plumbing – PVC
   c. Mixing chamber – PVC, acrylic
9. Mixing chamber – PVC, acrylic
   a. Dilution water – 120-1200 GPH primary mixing (456-4560 LPH)
      120-1200 GPH post dilution (456-4560 LPH)
   b. Metering pump – 0.5-10.0 GPH neat polymer (1.9-38.0 LPH)

D. Calibration Cylinder: A suitably sized calibration cylinder shall be supplied for the neat polymer feed pump. Cylinder shall be mounted to frame with PVC isolation ball valves. Cylinder shall be calibrated in mL, and be constructed of clear PVC with slip on cap and ½ inch NPT vent connection.

E. Drumstick: Rigid suction tube with 2 inch NPT x 5/8 inch O.D. barbed adapter. Drumstik suitable for threading into a standard 55 gallon drum, providing a sealed suction connection and facilitating evacuation of drum to greatest extent practicable.

F. Drumstir: Portable drum mixer capable of being flange mounted through 2 inch NPT opening of a standard 55 gallon drum. Flange and/or mixer designed so impeller will be centered in drum. Motor to be 1/2 HP, TEFC, 1725 RPM, requiring 120 volt, 60 hz 1 phase power supply, shaft and impeller of 304 S.S.

G. Pressure Reducing Valve: A suitably sized pressure reducing valve shall be supplied for installation in the dilution water line. Pressure reducing valve shall be constructed of bronze with adjustable output pressure of 25-75 psig to reduce incoming line pressure variations. Pressure reducing valve shall be as manufactured by Watts Regulator model U5 or U5B.

H. A neat polymer thermal loss of flow switch shall be supplied on the discharge of the neat polymer metering pump to detect absence of polymer flow. Thermal flow switch assembly shall include sensor, flow block and controls. Alarm output contacts shall be supplied for the plant control system after adjustable time delay.

I. Spare Parts:
   1. Unit B - Spare parts kit shall include mechanical seal, mixing chamber o-rings, injection check valve, and pump liquid end rebuild kit.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install polymer feed pumps and accessories in conformance with provisions in Section 11005 of Specifications, manufacturer's recommendations, and as shown on Drawings.

B. Install calibration kit in accordance with manufacturer's directions.

3.02 START-UP

A. Manufacturer's representative to check and verify that installation of equipment is in accordance with Drawings and manufacturer's installation instructions prior to starting equipment, and provide installation certificate.

B. General: Start-up and test in accordance with Section 01650 of Specifications.

C. Field Test: Test feeders in presence of Engineer to determine that equipment delivers chemicals within specified accuracy over range of feeder. Test a minimum of four set feed rates. Test each run for at least 10 minutes. Make no adjustments while test is in progress. In event equipment fails to meet specifications, make adjustments, modifications, or equipment changes as may be necessary to meet specified standards. Run new tests until equipment meets Specifications.

3.03 FIELD QUALITY CONTROL

A. Manufacturers Field Services:
   1. Provide factory trained manufacturer's representative to assist in supervising installation of liquid polymer feed equipment.
   2. Provide a minimum of two (2) days service, by a fully qualified manufacturer's service engineer to inspect completed installation, start equipment and place in operation, and train operators in its use and care.

END OF SECTION

SECTION 11245

CHEMICAL FEED PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of chemical feed pumps and accessories as shown in the Drawings and as specified herein. All equipment, systems and accessories to be furnished as part of the Phase 1 construction.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Products: Section 01600.
   3. Alternatives: Section 01100.
   4. Testing: Section 01650.
   5. Basic Equipment Materials and Methods: Section 11005.
   6. Basic Measurement and Control Instrumentation Materials & Methods: Section 13410.
   7. Division 16 – Electrical.

1.02 DEFINITIONS

A. Diaphragm Pump: A pump which moves process fluid by alternately withdrawing an elastomeric diaphragm to draw process fluid into the pump head and then compressing the diaphragm against the process fluid to discharge the fluid from the pump head.
   1. Hydraulic Diaphragm Pump: A diaphragm pump which uses a piston to move hydraulic fluid which in turn actuates the diaphragm and is driven by an electric motor.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. General: Pumps to be capable of pumping indicated liquids over range shown by manually adjusting stroke length over a 10:1 range. On SCR driven pumps, pump motor sped to be adjustable over a 20:1 range in proportion to a 4-20 mA pacing signal. Provide pumps capable of suction lift of 5 feet (min.) for each chemical being pumped.
      a. Hydraulic Diaphragm Pumps: Provide leak detection system which will shut down pump and output alarm signal to plant SCADA system upon failure of diaphragm.
   2. Control Panels:
      a. Constant Speed Pumps: Include provisions to accept remote Start/Stop signal from the plant SCADA system. Provide dry contacts for remote On/Off indication to the plant SCADA system. Coordinate with requirements of Section 13410.

b. SCR Driven Pumps: Include provisions to accept remote Start/Stop signal and remote 4-20 mA pacing signal from the plant SCADA system. Provide dry contacts for remote On/Off indication to the plant SCADA system. SCR drive to adjust motor speed in proportion to a rate set potentiometer in Local Control Mode. SCR drive to adjust motor speed in proportion to 4-20 mA pacing signal in Remote Control Mode. Coordinate with requirements of Section 13410.

3. Performance Requirements: Provide chemical feed pumps as indicated in following schedule. All pumps are as manufactured by Lutz-JESCO America Corporation, Rochester, New York.

Quantity	Chemical Pumped	PumpType **	No Heads Per Pump	Full Speed Capacity Range (gph)	SCR
_4_ Ea.	Polyaluminum Chloride	H	1	2.11 – 173.80	Yes
_3_ Ea.	Ferric Chloride (42° Be)	H	1	4.74 – 118.50	Yes
_3_ Ea.	Caustic Soda (25%)	H	1	0.52 – 82.27	Yes
_2_ Ea.	Corrosion Inhibitor (13.20 lb/gal)	H	1	0.11 – 3.95	Yes
_2_ Ea.	Hydrofluosilicic Acid (23%)	H	1	0.63 – 7.66	Yes
_2_ Ea.	Sodium Thiosulfate (30% wt.)	H	1	0.40 – 12.62	Yes
_2_ Ea.	Ammonia Hydroxide (19%)	H	1	0.42 – 6.30	Yes
_2_ Ea.	Potassium Permanganate	H	1	3.06 – 137.61	Yes
__ Ea.	Spare *				

* Spare pump system shall be suitable for feeding _____.

** Type "H" is a Hydraulic Pump.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings for the equipment in accordance with Section 01300 and Section 11005 demonstrating compliance with these Specifications.

B. Certificates: Manufacturer to certify chemical feed pumps and accessories will withstand continuous contact with intended chemicals without defects.

1.05 QUALITY ASSURANCE

A. General Requirements: Chemical feed pumps and accessories to comply with all provisions of Section 11005.

B. Basis of Design: Specifications are based on the Lutz-JESCO feed pumps. Contractor to bear any costs resulting from changes to the structure, piping, electrical work, plumbing work, etc., required for Wallace & Tiernan, Pulsafeeder, or Milton Roy feed pumps in accordance with Section 01100. Submit drawings to the Engineer for approval, showing the changes in the equipment, piping, structure, electrical work, and plumbing work.

C. Supplier Requirements: To ensure all equipment required for installation of feed pumps, controls, and other accessories is properly coordinated and will function in accordance with intent of these Specifications, obtain all equipment specified under this Section, from a single supplier in whom responsibility for proper function of all the equipment, regardless of manufacturer, as an integrated and coordinated system is vested. Intent of this paragraph is to establish unit responsibility for all equipment through feed pump equipment supplier. Use of the word "responsibility" relating to feed pump equipment supplier is not intended to relieve ultimate responsibility for equipment coordination, installation, operation, and guarantee.

D. All electrical control panels to be listed and labeled assemblies of a nationally recognized testing laboratory as outlined in NEC 90-7.

E. Project Conditions
   1. Perform power and control wiring to control panels and between control panels and chemical feed pumps as work of Division 16.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Hydraulic Diaphragm Pumps
   1. Lutz-JESCO Corp, Rochester, NY
   2. Wallace & Tiernan, Inc., Belleville, NJ.
   3. Pulsafeeder, Rochester, NY.
   4. Milton Roy, Flow Control Division, Ivyland, PA.

2.02 COMPONENTS

A. Pump Heads: Pump manufacturer to provide materials and head arrangement most compatible with the liquid being pumped.

B. Diaphragm: Provide tubular type diaphragms. Provide propylene glycol hydraulic fluid. Provide each pump with diaphragm leak detection system which will shut down pump and output alarm signal to plant SCADA system upon failure of the diaphragm.

C. Motors: Provide 1725 RPM TEFC chemical duty induction motors suitable for operation on a 115 volt, 60 hertz, 1 phase power supply for constant speed pumps. Provide 90 VDC permanent magnet TEFC chemical duty motors for operation with SCR variable speed drives. DC motors to include tachometer generator for feedback of actual motor speed.

D. SCR Variable Speed Drives: Provide SCR drives contained in control panel enclosures specified below and suitable for operation on 115 volt, 60 hertz, 1 phase power supply.

E. CONTROL PANELS
   1. Constant Speed Pumps: Provide wall mounted control panels including but not limited to Power ON/OFF selector switch; Motor START/STOP selector switch; Control Mode LOCAL/REMOTE selector switch; "Green" running light; disconnect switch; and fuses or circuit breaker. Provide NEMA 12 enclosures.
      a. Include provisions in the control panel to accept remote start signal from the SCADA system. Provide dry contacts for remote on/off indication to the SCADA system.
      b. Coordinate with requirements of Section 13410.
   2. SCR Variable Speed Drives: Provide wall mounted control panel including but not limited to the SCR drive; Power ON/OFF selector switch; Motor START/STOP selector switch; Control Mode LOCAL/REMOTE selector switch; manual speed adjustment potentiometer; Percent of Speed (0-100) indicator; "Green" running light; isolator for SCR; disconnect switch and fuses or circuit breaker. Provide NEMA 12 Enclosures.
      a. Include provisions in the control panel to accept a remote start signal and remote 4-20 ma Pacing Signal from the SCADA System. Provide dry contacts for remote on/off indication to the SCADA System.
      b. SCR drive to adjust motor speed in proportion to the positioning of a rate set potentiometer on the control panel in Local Control Mode. SCR drive to adjust motor speed in proportion to a 4-20 ma pacing signal in Remote Control Mode.
      c. Coordinate with requirements of Section 13410.
   3. Solenoid Diaphragm Pumps:
      a. Integral feeder mounted control panel mounted opposite liquid end. Panel to have 16 character dot matrix backlit display; locking stroke length adjuster; RED stop LED; six membrane touch pad for manual stroke frequency and function selection; GREEN power on/stroke LED; external circuit breaker reset button; Start/Stop input control; 4-20 mA external control; and power relay for stop alarm indication.
      b. Coordinate with requirements of Section 13410.

2.03 SOURCE QUALITY CONTROL

A. Shop Testing: Shop test SCR drives.

2.04 ACCESSORIES

A. Components
   1. Provide the following accessories with each feed pump head. Applicable sizes and arrangements are shown on the Drawings:
      a. Flexible suction and discharge tubing with clamps.
      b. Poppet-type sight flow indicator.

c. Pressure relief valves piped to relieve flow to the day tank of it's respective chemical, sized to meet maximum pump capacity.
d. Adapters.
e. Multi-function valve.

2. Provide the following accessories with each chemical feed pump:
   a. Pump and motor mounting plate.
   b. Wall mounting brackets.
   c. Belt guard (mechanical diaphragm pumps only)
3. Provide the following accessories with each chemical feed pump system. Applicable sizes and arrangements are shown on the Drawings.
   a. Back pressure and anti-siphon valve.
   b. Calibration chambers suitable for wall mounting.
   c. Pulsation dampeners.
   d. Multi-function valve.
4. Preventative maintenance kit for each feed pump.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install chemical feed pumps and accessories in conformance with provisions in Section 11005 manufacturer's recommendations, and as shown on the Drawings.

3.02 FIELD QUALITY CONTROL

A. General: Start-up and test equipment in accordance with Section 01650.

B. Field Test: Test the feeders in the presence of the Engineer to determine equipment delivers chemicals within the specified accuracy over the range of the feeder. Test a minimum of four set feed rates per maximum speed pulley and one feed rate for other pulleys (mechanical diaphragm pumps only). Test each feed rate for at least 10 minutes. Make no adjustments while the test is in progress. If the equipment fails to meet Specifications, make necessary adjustments, modifications, or equipment changes to meet the specified standards. Run new tests until the equipment meets the Specifications.

3.03 DEMONSTRATION

A. General: Train Owner's personnel in operation and maintenance of equipment in accordance with provisions of Section 11005.

3.04 PROTECTION

A. General: Protect installed equipment from damage in accordance with provisions of Section 01600 and Section 11005.

END OF SECTION

SECTION 11247

BATCH TANK MIXERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of batch tank mixers as shown in the Drawings and specified herein. All equipment shall be furnished under Phase 1 construction.

B. Related Sections:
   1. Submittals: 01300.
   2. Basic Equipment Materials and Methods: Section 11005.
   3. Division 16 - Electrical.

1.02 REFERENCES

A. American Gear Manufacturing Association (AGMA).

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01300 and Section 11005, shop drawings for the equipment demonstrating compliance with these Specifications.

1.04 QUALITY ASSURANCE

A. General: The batch tank mixers shall comply with all provisions of Section 11005.

1.05 DESIGN CRITERIA

A. General: The following schedule of batch tank mixers shall be supplied. All model types refer to Philadelphia Mixers, Division of Philadelphia Gear Corporation.

Batch/DayTank (Location)	Qty	No. Mixers Per Tank	Tank Size	Min. Mixer Hp	Mixer RPM	Model Type
Potassium Permanganate Solution Tank (RWPS)	1	1	1400 gallon 64"dia x 120" side shell height	3/4	350	POG-34

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Philadelphia Mixers, Division of Philadelphia Gear Corporation, King of Prussia, PA.

2. Lightnin Mixers, Rochester, NY

2.02 COMPONENTS

A. General: The mixers shall be top-entering with an adjustable C-clamp for mounting the mixers on their supports as shown in the Drawings.

B. Mixer Assemblies: All mixer assemblies shall be top entering with 3-blade, square pitch propellers. All wetted parts shall be 316 stainless steel. The size and length of shafts, impeller diameters and numbers of impellers and their locations for the chemicals and size of batch tank specified, shall be established by the mixer manufacturer and submitted to the Engineer for approval. The shaft length shall have an adequate allowance for mixer mounting distance above the batch tank. The manufacturer shall verify that the specified wetted parts are suitable for the proposed chemical.

C. Mixer Support Stands: Floor mounted mixer support stands as detailed on the Drawings shall be furnished to support the mixers at the settings established by the mixer manufacturer. Tank or wall mounted brackets will not be acceptable. Submit details of tanks, mixers and support stands.

D. Gear Drive. Gear-driven mixers shall be designed and manufactured for continuous service at rated horsepower using a single reduction internal helical gears per AGMA Standards. Gears shall be greased, lubricated and positively sealed against leakage and contamination.

E. Mixer Motors: All motors shall have a service factor of 1.15 and be suitable for 120-volt, 1-phase, 60-hertz power. They shall be totally enclosed fan cooled, chemically duty with Class B insulation. The total temperature rise shall not exceed the temperature standard for Class B insulation when operating at a maximum ambient temperature of 40° C. Starters for the mixer motors will be furnished and installed under Electrical Contract as work of Division 16 - Electrical. Provide power cord with a suitable plug.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install batch tank mixers in accordance with the requirements of Section 11005.

END OF SECTION

SECTION 11249

CHEMICAL FEED EQUIPMENT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of chlorine ton container scales, chlorine storage roller trunions, ton container lifting device, chlorine gas monitor and chemical weighing scales all as shown on Drawings and specified herein. All equipment, systems and accessories to be furnished as part of Phase 1 construction.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Product: Section 01600.
   3. Basic Equipment Materials and Methods: Section 11005.

1.02 REFERENCES

A. National Electrical Manufacturers Association:
   1. NEMA Standards Publications.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Chlorine Scale:
      a. Capacity: Sized to accept dual ton containers (8,000 lb).
      b. Quantity: 2.
   2. Chlorine Weight Transmitter
      a. Provide one transmitter for both scales.
      b. Channels: 1 to 4 with independent input/output controls.
      c. Increments: 1, 2, 5, 10, 20 and 50.
      d. Display Units: lbs., kg., and gallons.
      e. Accuracy: ±0.25 percent of full scale.
   3. Chlorine Storage Roller Trunions:
      a. Capacity - 4000 lb. Container
      b. Quantity: 2 per container, plus 2 spare.
   4. Ton Container Lifting Device:
      a. Capacity: 1 ton chlorine container
      b. Quantity: 1.
   5. Chlorine Gas Monitors:
      a. General: Systems designed to warn of presence of chlorine gas at sampling points shown on Drawings.
      b. Gas Detection: Presence of 1 ppm.
      c. Quantity: Chlorine - 3.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with Section 01300 and Section 11005, demonstrating compliance with specifications.

1.05 QUALITY ASSURANCE

A. General Requirements: Comply with all provisions of Section 11005 - General Equipment Requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Deliver, store and handle equipment in accordance with these specifications and manufacturer's instructions.

B. See Section 01600 for general handling, storage and protection requirements.

1.07 PROJECT CONDITIONS

A. All equipment specified in this section to be furnished by the chlorination system equipment manufacturer as part of the chlorination system package.

PART 2 PRODUCTS

2.01 CHLORINE SCALES

A. Construction:
   1. Electronic shear beam type.
   2. Contain required number of heavy roller trunions installed for each container to allow easy container rotation.
   3. Frame to tilt for easy cleaning.
   4. Size such that it is within dimensions of ton containers.

B. Cell: Single electronic shear beam type capable of withstanding shock and side loading associated with the use of ton cylinders.

C. Load Plate: Capable of tilting to 4 inches without effecting accuracy, to allow easy installation.

D. Cable: Furnish in sufficient length to allow remote installation of indicator.

E. Manufacturer:
   1. Force Flow Equipment, Chlor-Scale DR80.
   2. Capital Controls, Inc.

2.02 CHLORINE WEIGHT TRANSMITTER

A. Furnish with weight transmitter capable of accepting 1 to 4 separate inputs and outputting independent 4-20 mA analog signals proportional to weight remaining in containers.

B. Electrical Requirements: Indicator and Transmitter capable of operation on a single 120 volt, 60 Hz, 1 phase power supply. Provide NEMA 4X enclosure.

C. Manufacturers:
   1. Force Flow Equipment, Wizard 4000 Inventory Management System.
   2. Capital Controls, Inc.

2.03 STORAGE TRUNIONS

A. General: Furnish two per ton container plus two spare. Position as indicated on drawings.

B. Materials:
   1. Trunion base: Fabricated steel, epoxy coated.
   2. Rollers: Cad plated, bronze bushed.
   3. Roller pins: Cad plated with alemite grease fittings.

C. Manufacturers:
   1. Force Flow Equipment, Model 21L.
   2. Capitol Controls, Inc.

2.04 TON CONTAINER LIFTING DEVICE

A. Materials: Welded steel. Meet or exceed Chlorine Institute design standards.

B. Manufacturers:
   1. Babcock Industries, Inc., Acco Products Division (Wallace & Tiernan)
   2. Capitol Controls, Inc.

2.05 CHLORINE GAS MONITORS

A. General: Furnish chlorine monitors for mounting as indicated on drawings.

B. Sensor/Transmitter: Provide electrochemical gas sensor for location in areas where gas leak may occur. Transmitter to send 4-20 mA signal indicating gas measurement to receiver. Transmitter to be capable of transmitting signal up to 1000 feet without additional amplification. Provide NEMA 4X enclosure for sensor/transmitter.

C. Receiver Module: Provide receiver to signal presence of gas. Receiver to include LED display, two adjustable gas alarm set points and three configurable and assignable gas alarm relays. Provide receiver module in NEMA 4X enclosure.

D. Power Supply: Provide power supply suitable for operation of 120 VAC power input. Mount power supply in same NEMA 4X enclosure as receiver module. Power supply to be capable of powering receiver module and charging back-up battery.

E. Battery Back-up: Provide sealed battery back-up capable of powering receiver module for up to 12 hours in event of a power outage. Battery to be automatically and continuously charged by power supply module.

F. Spare Parts: Provide one spare sensor/transmitter and one test gas generator.

G. Manufacturers:
   1. Wallace and Tiernan, Acutec 35.
   2. Capital Controls, Inc.

2.06 WATER SOFTENING EQUIPMENT

A. Flow, maximum continuous, 20 gpm at 10 psi pressure drop.

B. Treatment Requirements:
   1. Maximum inflow hardness – 8 grains per gallon
   2. Outlet hardness 18 mg/L backwash flow.

C. Operating Inlet Pressure – 70 psi

D. Minimum Operating Outlet Pressure – 60 psi.

E. Salt Usage – 150 lbs per regeneration per unit.

F. Regeneration Rate – every 25,000 gallons used.

G. Brine Tank Capacity – 700 lbs salt.

H. Softener Tank Resin Volume – 5 cubic feet.

I. Exchange Capacity - 30,000 grains/cubic foot

J. Number of Softener Tanks – 2

K. Number of Brine Tanks - 1

L. Controls: Fully automatic rotary pilot valve with hydraulic diaphragm valves. Turbine meter on discharge and solid state control device (120 V, single phase power) to permit regeneration on throughput volume. Water quality sensing system to monitor exchange capacity and initiate backwash.

M. Manufacturer
   1. Fleck 5600 Econominder

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install all equipment in accordance with Drawings and manufacturer's instructions.

B. Chlorine Scale: Install conduit from indicators to scales of a suitable size to pass flexible hose.

END OF SECTION

SECTION 11261

CHLORINATION EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of gas feed equipment and appurtenant system components for chlorine. All equipment to be furnished under Phase 1 construction.

B. Related Sections:
1. Submittals: Section 01300.
2. Testing: Section 01650.
3. Basic Equipment Materials and Methods: Section 11005.
4. Basic Measurement and Control Instrumentation Materials and Methods: Section 13410.
5. Section 11249 – Chemical Feed Equipment Accessories.

1.02 SYSTEM DESCRIPTION

A. Cabinet Mounted Gas Feeders: Provide four (4) wall mounted non-metallic cabinets with remote vacuum operated solution feeders for chlorine.

B. Control Methods: Provide manual and proportional, and control of gas feeders as indicated below.

Gas Feeder Description	Automatic Control Method
Cabinet Mounted Pre\Spare Chlorinator	Proportional via DCS
Cabinet Mounted Filter Influent Chlorinator	Proportional via DCS
Cabinet Mounted Post Chlorinator	Proportional via DCS
Cabinet Mounted Post Chlorinator	Proportional via DCS

C. Evaporators: Maximum capacity of 10,000 pounds per day.

D. Injectors: Remote mounted injectors

Injector Description	No. Req'd	Size (inches)	Capacity (lbs/day)	Operating Water Supply (gpm)	Operating Water Pressure (psig)	Backpressure at Injector (psig)
Pre/Spare Chlorinator	1	2 Variable Throat	1500	65	50	10.4
Filter Influent Chlorinator	1	2 Variable Throat	1000	40	50	3
Post Chlorinator (Clearwell Influent)	2	2 Variable Throat	1000	75	50	16
Post-Chlorinator (Clearwell Effluent)	1	2 Variable Throat	1000	50	50	11

1.03 SUBMITTALS

A. Shop Drawings: Submit in accordance with Section 01300 - Submittals.

B. Additional Information: Submit charts showing injector operation at various supply pressures, back pressures and feed rates.

C. Submit written installation, operation, and maintenance instructions.

1.04 QUALITY ASSURANCE

A. General: Comply with all provisions of Section 11005 - General Equipment Requirements.

B. Basis of Design: Drawings and Specifications are based on Wallace and Tiernan equipment. Assume responsibility for changes to structure, piping, electrical work, plumbing work, etc., required for other manufacturers equipment. Submit drawings for approval, showing changes in equipment, piping, structure, electrical work, and plumbing work.

C. Qualifications: Purchase gas feed equipment and appurtenant system components specified in this Section from one manufacturer.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers
   1. Wallace & Tiernan
   2. Capitol Controls, Inc.

2.02 GAS CHLORINE EQUIPMENT

A. Vacuum Regulators: Furnish vacuum regulator check units with 115 volt drip leg heaters, heavy duty power cords and standard 3-prong plugs. Installed assembly will maintain proper operating vacuum, shut off gas supply if operating vacuum is lost. Each valve to include internal pressure relief device.
   1. Each Regulator: 1,000 lb/day capacity.

B. Automatic Switchover: Wall mounted automatic switchover capacity 1500 lbs per day minimum.

C. Cabinet Data: Include injector vacuum gauge, rotameter, manual feed rate control knob, and electronic controller on face of cabinets. Provide vacuum switches for high and low vacuum alarm output to control panel.

D. Injector Assembly: Furnish differential pressure type, PVC or cast iron body injectors with built-in double ball check valves and spring loaded diaphragm check valves. Injectors to be remote wall mounted. Furnish appropriate wall mounting brackets and hardware.

E. V-Notch Controllers:
   1. General: Chlorinators controllers to receive a proportional 4-20 ma pacing signal established in the DCS. Each controller drives an electric actuator which adjusts the variable v-notch orifice and, therefore, chlorine gas flow rate. Provide 4-20 mA output for actuator position to DCS. Controller enclosures rated NEMA 12.
   2. Each chlorinator control panel to include a Power ON/OFF/REMOTE switch; dosage control potentiometer with electronic manual override; actuator motor disengaged light; no flow alarm light; LED bar graph which reads out flow input or chlorinator feed rate in 5% increments; and independent zero and span adjustments for flow input. When power switch is in REMOTE position, power to controller will be turned on and off by a remote signal. Controllers surface mounted in chlorinator cabinets.
   3. Coordinate controls with requirements of Specifications Section 13410.

F. Electric V-Notch Actuator: Single phase reversible motor with mechanical manual override, feedback potentiometer and thermal-overload protection in NEMA 4X enclosure. Provide actuator with three alarm relays for high limit, low limit and motor disengage and 4-20 mA output for actuator travel.

G. Dosage Control: Manually or automatically set by adjusting a variable orifice in gas feed housing.

H. Alarms: In addition to alarm indication lights on controllers, provide following contacts for alarm output:
   1. Pre/Spare Chlorinator:
      a. High/Low vacuum alarm
      b. Chlorine gas NoFlow alarm
      c. Selected chlorinator off
   2. Filter, Post Chlorinators:
      a. High/Low vacuum alarm
      b. Chlorine gas NoFlow alarm
      c. High/Low Residual Alarm
      d. Residual deviation alarm (activates at 15%±, 30%±, or 50%± deviation from setpoint).
   3. Alarms wired so that they are disabled when power to controller is turned off.
   4. Coordinate alarms with requirements of Specifications Section 13410.

I. Electrical Requirements: Each controller to receive a single 120 volt, 60 hertz, 1-phase power supply. Actuators receive power from controllers. Pacing signals to be 4-20 mA dc.

2.03 ACCESSORY EQUIPMENT

A. Furnish accessory equipment listed below and as shown on Drawings.
   1. One spare injector assembly of each size specified in the system description.
   2. Two (2) flexible auxiliary ton container connections (header valve and tubing).
   3. Four (4) chlorine gas auxiliary header valves (Two with plugs).
   4. Two (2) complete sets of wrenches to fit all accessories.
   5. Two (2) 4 ounce bottles of ammonia.
   6. Two (2) tubes of lubricant.
   7. Two (2) gas masks of air-pack type suitable for use with type of gas being fed. Mount in a suitable MSA wall mounted rack in which personnel can back into and remove air pack from rack. Units to have service life of 30 minutes. Components to include face piece, demand regulator, high pressure hose, audible alarm on low pressure, cylinder and harness. Unit to have NIOSH approval. Unit to maintain a slight positive pressure within face piece to prevent leakage of toxic gases into face piece area. Manufacturer to be Scott Air Pressure Pack 2. Packs to be housed in NEMA 12 enclosure.
   8. Two (2) insect screens for mounting on vents.
   9. Two (2) vacuum regulator check unit assembly with two (2) 115 volt heaters rated at 1000 lb/day chlorine.
   10. One (1) automatic switchover unit rated at 1500 lbs per day.
   11. Furnish gas pressure gauges with safety diaphragms and header valves suitable for gas being fed where shown on drawings. Include (2) spare gauges and diaphragms.
   12. Line valves, unions and strainers on gaslines, located as shown on Drawings.

13. Ton container repair kit, Chlorine Institute Kit "B".

PART 3 EXECUTION

3.01 INSTALLATION

A. Install as shown on drawings and in accordance with manufacturer's written instructions.

3.02 FIELD QUALITY CONTROL

A. Manufacturer's Field Services
   1. Provide Factory Trained Manufacturer's Representative for a minimum of one day to assist in supervising installation of equipment.
   2. Provide service by a fully qualified Manufacturer's Service Engineer to inspect completed installation, start equipment and place in operation, and train operators in its use and care.
   3. Service Engineer to furnish installation certificate.
   4. Field services to be provided in accordance with Section 11005.

3.03 START-UP

A. Start-up and field test in accordance with Section 01650 - Testing.

END OF SECTION

SECTION 11311

NON-CLOG CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section generally consists of equipment and services for providing non-clog centrifugal pumps to be used as wastewater clarifier sludge transfer pumps, submittals, inspection, startup, testing, and training.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Paints and Coatings: Section 09900.
   3. Process Piping: Section 15200.

1.02 REFERENCES

A. American Society for Testing and Materials:
   1. ASTM A48, Specification for Gray Iron Castings.

B. National Electrical Manufacturers Association (NEMA).

C. Institute of Electrical and Electronics Engineers (IEEE).

D. Underwriters Laboratories, Inc. (UL).

E. American Bearing Manufacturers Association (ABMA).

1.03 SUBMITTALS

A. Submit shop drawings for pumping equipment in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications, including;
   1. Manufacturer's literature, illustrations, specifications and engineering data defining materials of construction, dimensions, weights, and pump motor performance.
   2. Parts list including a list of recommended spare parts and maintenance tools.
   3. Location of nearest permanent service headquarters.
   4. Head vs. capacity, efficiency, brake horsepower and NPSH curves.
   5. Written instructions, operation and maintenance instructions.

1.04 QUALITY ASSURANCE

A. Provide pumps designed and constructed in accordance with standards of the Hydraulic Institute. The efficiency of the pumps, when operating under conditions of the specified capacities and heads, shall be as near peak efficiency as practicable.

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B. Pumps designated as non-clog centrifugal shall pump water or sewage containing solids up to 1 percent, with a minimum of clogging.

C. Obtain pumping equipment, motors, and appurtenances from the pumping system supplier whose responsibility it is to insure that the pumping equipment is properly coordinated, installed, and initially operated in accordance with these Specifications.

D. Requirements of Regulatory Agencies: Comply with construction requirements of State, County, and such other local political subdivision specifications as may exceed the requirements of the codes, standards, and approving bodies referenced herein.
   1. Comply with requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels and Certifications and the National Electrical Manufacturers' Associations (NEMA) Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the Equipment.

E. 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, that is, items having both primer and final finish coatings, except as specified in Section 09900.

F. Basis of Design: Drawing layout and Specifications are based on Flowserve horizontal non-clog centrifugal pumps. Any costs resulting from changes to structure, piping electrical work, plumbing work, etc., required for another pump manufacturer's pumps, borne by Contractor. Submit drawings to Engineer for approval, showing changes in equipment, piping, structure, electrical work, and plumbing work.

1.05 DELIVERY, STORAGE AND HANDLING

A. General Requirements: In addition to requirements for materials handling and storage as stated in the General Conditions of the Contract; the following applies:
   1. 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.
   2. Store materials, equipment and machinery, both on and off site, in accordance with manufacturer's written instructions.
   3. 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 JOB CONDITIONS

1. Wiring: Wiring to and from starters, switches, relays, and contacts to be performed under Division 16 – Electrical.

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PART 2 PRODUCTS

2.01 HORIZONTAL NON-CLOG CENTRIFUGAL PUMPS

A. Acceptable Manufacturer.
   1. Flowserve.
   2. Peerless.
   3. PACO.

B. General Requirements: Provide horizontal non-clog centrifugal pumps located as indicated on the Drawings.
   1. Performance Criteria:
      a. Design Flow: 705 gpm.
      b. Head: 15.0 ft.
      c. Efficiency: 74.4%
   2. Performance Criteria:
      a. Suction Size, inches: 6.
      b. Discharge Size, inches: 6.
      c. Sphere Passage, inches: __.
      d. Design Horsepower: 3.59.
      e. Maximum Speed, rpm: 885.
      f. Power, volts/phase/hertz: 480/3/60.
      g. Maximum Motor Full Load Amps: ___.
   3. Rotation: The pumps shall rotate in the clockwise direction when viewed from the motor end.

C. Pump Construction:
   1. Casing: Single volute type casing of close-grained ASTM A48 Class 30 cast iron designed to provide accurate alignment and prevent excessive deflection. The casing shall be comprised of three separately cast components: volute, fronthead, and backhead.
      a. Each casing factory tested hydrostatically to twice the design head, or one and one half times the shutoff head, whichever is greater.
      b. The volute shall be sized at all points to pass solids which can pass through the impeller and internally finish to provide smooth unobstructed flow. The volute shall have a tangential discharge and be capable of rotation in 45 degree increments to accommodate piping orientation. The volute provided with a cleanout opening with removable cover, having its interior surface matching the volute contour, allowing access to the interior of the impeller.
      c. The pump casing shall be so arranged that the impeller may be removed without disturbing either suction or discharge piping. The fronthead shall be connected to the volute and suction elbow. The fronthead shall be machined to receive a renewable wearing ring of 400 series stainless steel having a Brinnell hardness of 300 to 350, and held in place by headless brass screws or other approved device. The backhead of the casing shall consist of large access openings and integral sealing box.

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d. The sealing box shall be designed for use with a double mechanical seal and furnished with a 1/4-inch injection and vent tap for a clear water connection to a water seal ring. Water seal ring designed to prevent air from entering the pump through the sealing box. Provide a 3/4-inch minimum sealing box drain tap. Provide solid steel gland. Contractor shall refer to the sealwater piping diagram on the Drawings, and the components specifications in Section 15200.
e. Suction and discharge connections shall be provided with ANSI 125-pound flat face flanges.
f. Pump casing drilled and tapped for draining, venting, seal water and a pressure gauge. Pump casing provided with eye bolts, lifting lugs or equivalent.

2. Impeller: Enclosed, two-vane, non-clog type impeller of close-grained ASTM A48 Class 30 cast iron. Impeller shall be statically and dynamically balanced. The impeller shall be key set to the shaft and secured with a stainless steel hex head impeller nut and washer. The impeller shall not unscrew or loosen from torque in either forward or reverse rotation. The impeller shall be machined to receive a renewable wearing ring of 400 series stainless steel having a Brinnell hardness of 300 to 350, and held in place by headless brass screws or other approved device.
3. Pump Shaft: 416 stainless steel of sufficient strength and size to safely transmit the maximum torque developed by the motor. Shaft shall provide rigid support for the impeller and prevent excessive vibration over the full range of operating speeds. The first critical speed of the shaft, including impeller, shaft sleeve and coupling, shall not be less than 150 percent of the maximum operating rpm. Provide a renewable straight shaft sleeve, positive adhesive sealed to prevent leakage between the shaft and sleeve, to protect the shaft through the sealing box area. The shaft sleeve shall be stainless steel with a Brinnell hardness between 300 and 350.
4. Pump Shaft Bearing Frame: Close-grained ASTM A48 Class 30 cast iron, one-piece construction sufficiently rigid to resist all imposed forces. Bearing frame provided with lip type grease seals for protection against dust and moisture. Grease fittings shall be provided for bearing lubrication. Provide jacking bolts for external impeller adjustment.
5. Pump Shaft Bearings: Single row, grease lubricated ball bearings. Lower (or inboard) bearing shall be designed to carry the hydraulic radial loads encountered in service conditions. Upper (or outboard) bearing shall be designed to carry the pump hydraulic axial and dead load thrust. Bearings shall be designed for a minimum B-10 bearing life of 50,000 hours per ABMA test procedure at the design point. Bearings shall be commercially available.
6. Shaft Seal: Provide a double mechanical seal composed of two separate lapped seal faces, consisting of one stationary silicone carbide and one rotating tungsten carbide face, held in place by a stainless steel spring. Use commercially available seals.
   a. Provide 1/4 inch injection and vent tap for connection of seal water piping.

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7. Base: Provide a heavy duty fabricated steel base with openings large enough to permit access to the suction elbow and cleanout. The base shall be manufacturer's standard design to support the assembled weight and operational stresses of the pump and motor.

2.02 CONTROLS

A. Overview: The overall pumping system is generally comprised of two centrifugal, non-clog wastewater pumps, pressure switches and gauges with diaphragm seals (low, medium, high), and a level transmitter. The control objective is to control pump and valve settings based on the basin level transmitter.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment with skilled mechanical erection labor in accordance with manufacturer's instructions.

B. As part of the installation, apply an anti-seize compound to threaded fasteners of equipment components which may require removal, replacement, or adjustment as part of normal maintenance or inspection procedure.

C. Obtain manufacturer's certifications on equipment as being installed adjusted and approved satisfactory and completely ready for operation.

D. Furnish the Engineer with manufacturer's certificates regarding equipment installation prior to Initial Mechanical Performance Test.

E. Field Painting: As specified in Section 09900.

3.02 FIELD QUALITY CONTROL

A. Conduct testing in accordance with Section 01650 and details provided hereinafter.

B. Preliminary Testing.
1. Provide services of a manufacturer's representative for a minimum of 8 hours for testing.
2. Run pumps to verify the head, capacity, efficiency and horsepower of the pumps at shutoff, and the three equally spaced design points.
   a. Flow. Measure flow from meter or by other reliable means as provided by Contractor.
   b. Head. Measure pressure using calibrated test gauges (suction and discharge) capable of accurate readings to 0.25 psi ±.
   c. Amperage and Voltage. Provide calibrated amperage and volt meter to measure power input to the pumping units.
   d. Power Factor. Use certified power factor of the motor as provided by the manufacturer.

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e. Acceptable Fluctuations in Test Readings As Long as Motor Does Not Overload.
   1) Differential pressure across pump (ft): +5% x ft
   2) Flow (Q): +10% x Q
   3) Power input to motor (bhp): +5% x motor hp

3. Vibration. Measure vibration on bearing housing to meet maximum vibration standards allowed in the American National Standard for Centrifugal Pumps of the Hydraulic Institute Standards. The manufacturer shall provide the calibrated instrument along with a Certificate of Calibration.
4. Cavitation. Check for cavitation noise by listening for the gas impinging on the impeller and volute. Any indication of cavitation is unacceptable.

C. Final Testing. The services of the manufacturer's representative will not be required, but he shall be alerted to be on call if his services are required. Run the test in conjunction with the final Mechanical Performance Test described in Section 01650. Observe the units for the following:
1. Overheating or Overloading the Motor.
2. Cavitation Noise.
3. Vibration.
4. Lubrication.

D. Manufacturer's Service. The services of the manufacturer's service representative for start-up and testing shall be borne by the Contractor and shall be included in the Contract bid price. No time or trip limitation shall be placed on these services.

E. Correct all deficiencies to satisfaction of Engineer.

3.03 DEMONSTRATION

A. Startup and test system in accordance with Section 01650.

B. Have factory-trained manufacturer's representative instruct plant personnel on repair and maintenance of pumping unit for time period indicated in Section 11005.

3.04 PROTECTION

A. After installation, protect drive units from moisture and temperature in accordance with Section 01600. Provide heated covers and enclosures where necessary.

END OF SECTION

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SECTION 11322

PROGRESSIVE CAVITY PUMPS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for four (4) progressing cavity type sludge transfer pumps to be located in the Wastewater Pump Station, and three (3) progressive cavity type polymer pumps in the Residuals Dewatering Building. One of the polymer pumps will be installed to recirculate the polymer in the polymer bulk storage tank, another will transfer polymer from the bulk tank to the day tank, and the third will be a spare pump placed into storage.

B. All progressive cavity pumping equipment, except for one (1) sludge transfer pump, is to be furnished as part of the Phase 1 construction. The one (1) remaining sludge transfer pump is to be furnished as part of the Phase 2 construction.

C. Related Sections:
   1. Submittal Procedures: Section 01300
   2. Products: Section 01600
   3. Testing: Section 01650.
   4. Paints And Coatings: Section 09900.
   5. Basic Equipment Materials and Methods: Section 11005.
   6. Division 16-Electrical.

1.02 REFERENCES

A. Institute of Electrical and Electronic Engineers (IEEE).

B. National Electric Manufacturers Association (NEMA).

1.03 QUALITY ASSURANCE

A. General: Pumping equipment and controls to comply with all provisions of Section 11005.

B. Basis of Design: Specifications are based on Moyno pumping equipment as manufactured by Robbins Meyers. Submit drawings to Engineer for approval.

C. Erection Qualifications: Install pumping equipment with skilled erection labor in accordance with manufacturer's written instructions. Consult manufacturer's representative during installation.

D. Requirements of Regulatory Agencies: Construction code requirements of State, County or other political subdivision which exceed requirements of national codes, standards and approving bodies to be complied with.

1.04 SUBMITTALS

A. Furnish Engineer with manufacturer's certificate regarding equipment installation prior to initial operation and mechanical performance test.

B. Shop Drawings and Product Data:
   1. Submit in accordance with these Specifications and Section 11005, manufacturer's published detail drawings, modified to suit design conditions if required.
   2. Submit in accordance with these Specifications, manufacturer's descriptive literature and specifications covering product specified. Include installation information, pump component parts drawings, system head curves, motor data, operation and maintenance instructions, etc.

1.05 DESIGN CRITERIA

A. Pumps to be suitable for pumping specified liquid. Pump, gear reducer, V-belt drive, and overhead mounted motor to be provided on a common baseplate.

B. Pumping Equipment:

Description	Sludge Transfer Pumps (3 pumps included in Phase 1 and 1 pump included in Phase 2)
General Pump Requirements	
Suction Diameter	8 inches
Discharge Diameter	8 inches
Liquid to be Pumped	Thickened sludge (1.2-5.5 % conc.)
Design Points	
Capacity	200 gpm
TDH	120 feet
Motor Requirements	
Voltage	230/460
Phase	3
Hz	60
Horsepower	20
RPM	1160
Enclosure	TEFC
Service Factor	1.15
Rating	Inverter Duty

Description	Polymer Recirculation & Transfer Pumps (All pumps are included in Phase 1)
General Pump Requirements	
Suction Diameter	4 inches
Discharge Diameter	4 inches
Liquid to be Pumped	40-50 % active Polymer 1500 cps-5500 cps
Design Points	
Capacity	50 gpm
TDH	20 feet
Motor Requirements	
Voltage	230/460
Phase	3
Hz	60
Horsepower	3
RPM	1160
Enclosure	TEFC
Service Factor	1.15
Rating	Inverter Duty

C. The third polymer pump will be a spare pump and placed into storage.

1.06 DELIVERY, STORAGE AND HANDLING

A. Unload equipment with care. In event of damage make repairs or replacements at no increase in Contract Price. Follow manufacturer's instructions for unloading equipment.

B. Store and protect equipment in strict accordance with manufacturer's written instructions.

1.07 PROJECT CONDITIONS

A. Wiring: Wiring from MCC to VFD and VFD to pumps shall be as shown on the Electrical drawings.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturer:
   1. Moyno
      a. Model 2000 G1 Model 2F0900G1CDQAAA (for sludge)
      b. Model 1000 Model A1GSSFAAA (for polymer)
   2. Mono
   3. Netzsch

2.02 PROGRESSIVE CAVITY PUMPS

A. General:
   1. All bolts and nuts to have hexagon heads.
   2. Type 304 stainless steel anchor bolts furnished and sized in accordance with manufacturer's recommendations.
   3. Each pump furnished with a stainless steel data plate securely attached to unit. Data plates to contain pump designation, manufacturer's name, pump size and type, serial number, speed, capacity and head rating and other pertinent data.

B. Pumps:
   1. Progressive cavity positive displacement type providing a cushioned positive flow assuring nonpulsating low shear transmission of liquid pumped. Pump to be cradle mounted to allow suction port to be rotated to any angle perpendicular to centerline.
   2. Cast iron pumps shall have an ASTM A331-90 alloy steel rotor (for sludge), or 416SS chrome plated rotor (for polymer), and a rubber Nitrile 100 stator. Stator of double helix configuration with nitrile elastomer chemically bonded to a steel tube. Stator fastened to suction housing and discharge flange with removable clamp rings to facilitate removal. Stator seals designed to prevent material being pumped from contacting stator bonding and tube.
   3. Suction and Discharge Connections: 150 lb. flanges.
   4. Stuffing Box: Stuffing box provided with a split packing gland and split Teflon lantern rings. Fittings shall be provided for grease lubrication of the packing
   5. Drive Train:
      a. Rotor connected to drive shaft by a gear type universal joint. Universal joint permanently grease lubricated and sealed against contamination by pumped fluid. Mechanical components designed to operate for 10,000 hours at maximum speed and pressures.
      b. A rigid splined connecting rod shall be provided to connect gear joints of drive shaft and eccentrically moving rotor. Connecting rod to pass through shaft seal area inside a hollow drive shaft quill so no eccentric loads are imparted on shaft seal area. Drive shaft of one piece construction through bearings and shaft seal area. Design will allow disassembly of universal

joints without affecting alignment of shaft in shaft sealing area. Quill portion of shaft is to be replaceable.

c. Drive end of shaft supported by tapered roller bearings, grease lubricated, and designed for a minimum ANSI B.10 life.

d. Connecting rod and drive shaft protected by a non-rotating shroud.

6. Pump and motor mounted on a common fabricated steel base plate. Motor mounted in overhead configuration with V-Belt drive.

C. Fluid Detection Systems:

1. Thickened Sludge Pump: The pump manufacturer shall provide one (1) pressure sensing fluid detection system for assembly on the discharge side for each progressing cavity pump assembly in accordance with the pump manufacturer's recommendations.
2. The fluid detector shall receive 115 VAC power supply from the respective pump VFD.
3. Pressure Sensor: .
   a. The control shall utilize a pressure sensor/isolator to separate the process fluid from the pressure sensing instrumentation.
   b. The process fluid pressure shall be transmitted by liquid silicone oil sealed ring between a carbon steel housing and a flexible elastomer element of BunaN.
   c. The pressure sensor elastomer element is to have integrally molded flange face gaskets and lip seals, and be compatible with 125 lb. ANSI flanges.
   d. The pressure switches (1.5 psi to 60 psi) shall stop the pump if no-flow (low pressure) or high discharge pressure occurs. Pressure switches shall be dual set point.
   e. A Pressure gauge (0 to 60 psi) shall be mounted in parallel with each pressure switch.
   f. Pressure gauges shall meet or exceed the requirements of specification section 13420.
   g. The pressure switch shall have a set point pressure at which the pump will be shut down.
4. The fluid detection system shall be provided with a control box to shut the pump down upon loss of fluid, low pressure, or high pressure. The pump will remain stopped until the a reset button in the control panel is pressed.

2.03 ELECTRICAL REQUIREMENTS

A. Electric Motors:

1. Type: Horizontal, totally enclosed fan cooled, ball bearing motor, rated for operation in a humid environment. VFD rated.
2. Standards: Motor to conform to NEMA Standards MG, applicable IEEE Standards, and applicable ASA C40 Standards.
3. Warranty: Motor free of defects in material and workmanship, and guaranteed to operate satisfactorily under proper application.
4. Design Characteristics: Motor to have following minimum characteristics:

a. 3-phase, 60 cycle
b. NEMA Design B
c. Normal starting torque
d. Class F insulation
e. 40° C ambient
f. Suitable for V-Belt drive
g. Service factor = 1.15
h. Premium efficiency

5. Frame: Motor frame of corrosion-resistant cast iron or cast steel. Mounting ring, unless otherwise approved, built integral with frame.
6. Bearings and Lubrication: Double shielded, grease lubricated, single row width ball bearings made from vacuum degassed steel. Readily accessible inlet and outlet plugs or fittings to allow for changing grease.
7. Conduit Box and Leads: Diagonally split conduit box, rotatable in 90° steps and provided with knockouts. A gasket furnished between conduit box and frame. Leads of stranded wire, suitably insulated and permanently identified with crimp-on solderless connectors.
8. Hardware: Stainless steel nameplates with embossed or preprinted lettering fastened to motor frame with corrosion resistant pins. All bolts and cap screws of high strength, zinc-plated and chromated steel. Nameplate data to include manufacturer's name, pump number, phase, horsepower, rpm, ampere and volt ratings, efficiency, power factor, enclosure insulation and frame size.
9. Manufacturer: Pump motors as manufactured by one of following:
   a. U.S. Electrical Motors
   b. General Electric Company
   c. Reliance

2.04 SPARE PARTS

A. One stator per pump

B. Two stator gasket sets per pump

C. One rotor per pump

D. One set seal packing and lantern ring set per pump

E. Pump and motor bearings

F. One gear joint seal kit per pump

G. One gear joint kit

PART 3 EXECUTION

3.01 INSPECTION

A. Refer to manufacturer's instruction and installation manual before proceeding with installation of equipment.

B. Examine equipment and components for damage or loss. Inform Engineer of damage, loss, or defects. Do not proceed with installation until damage, loss or defects have been corrected.

3.02 INSTALLATION

A. Install each pump in accordance with manufacturer's literature.

B. Set units level and true, shim to proper elevation and grout in place using nonshrink, nonmetallic grout. Do not grout units in place until installation has been inspected by a manufacturer's representative.

3.03 PAINTING

A. Field paint each pump, motor and base plate in accordance with Section 09900.

3.04 START-UP AND TESTING

A. See Section 01669 for general testing requirements.

B. Run pumps in field, witnessed by Engineer, to verify operation under field conditions. Object is to determine that pumping units will operate at specified head and capacity satisfactorily without overheating or overloading of motor, and free of vibration throughout entire operating range of head and capacity at rated speed.

C. Correct all deficiencies to satisfaction of Engineer.

3.05 FIELD QUALITY CONTROL

A. Manufacturers Field Services:
   1. Provide a factory-trained engineer for equipment installation, start-up and training in accordance with the provisions of Section 11005.

END OF SECTION

SECTION 11336

CLARIFIERS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of the construction of two circular batch wastewater clarifiers including drive, scraper arms and accessories as indicated on the Drawings for removing sludge from filter backwash and rinse water. All equipment and accessories to be furnished as part of Phase 1 construction, except if Phase 2 facilities are constructed, in which case Clarifier No. 2 sludge collection mechanism is rated the same as Clarifier No. 1.

B. Related Sections:
   1. Submittal: Section 01300.
   2. Cast-In-Place Concrete: Section 03300.
   3. Grouts: Section 03600.
   4. Metal Fabrications: Section 05500.
   5. Aluminum Fabrications: Section 05600.
   6. Paints and Coating: Section 09900.
   7. Basic Equipment Materials and Methods: Section 11005.
   8. Division 16: Electrical.

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA):
   1. AGMA 2001-C95; Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.
   2. AGMA 6017-E86; Rating and Application of Single and Multiple Reduction Double-Enveloping-Worm and Helical-Worm Speed Reducers.
   3. AGMA 6030-C87; Design of Industrial Double-Enveloping Wormgears.
   4. AGMA 6034-B92; Practice for Enclosed Cylindrical Worm Gear Speed Reducers and Gearmotors.

B. American Society For Testing and Materials (ASTM):
   1. ASTM A36; Standard Specification for Structural Steel.
   2. ASTM A48; Standard Specification for Gray Iron Castings.
   3. ASTM A536; Specification for Ductile Iron Castings.

C. American Welding Society (AWS):
   1. ANSI/AWS D1.1; Structural Welding Code-Steel.

D. Electrical Manufacturers' Association (NEMA).

E. Underwriters Laboratories Inc. (UL) Listings and Approvals.

F. American Society for Testing and Materials (ABMA).

1.03 SYSTEM DESCRIPTION

A. Clarifier Components: The clarifier mechanism shall be of the center drive type, supported on a stationary influent column. The clarifier shall include a walkway with handrails, drive mechanism, center drive platform, center support column with inlet openings, influent well, center cage, rake arms with plow blades, the necessary anchoring and assembly hardware, and appurtenances specified, indicated on the Drawing, and otherwise required for a complete and properly operating installation.

B. Process Operation: The clarifier equipment shall provide settling of filter backwash and rinse water, and removal of settled solids from the clarifier floor. There are two phases of construction to be considered as alternate scenarios for this project. Phase one construction shall provide a plant capacity of 20 mgd. A component of phase one construction shall be to make provisions for Clarifier No. 2 to be able to act as a thickener when the primary thickener is out of service. Phase two construction shall provide a plant capacity of 30 mgd. As a part of phase two construction there will be no provisions made to either clarifier to be able to act as a thickener. The following arrangement is consistent with both construction scenarios:
   1. Influent shall enter the clarifier through the centrally located influent well which is designed to prevent short-circuiting and to direct flow radically outward and downward. Solids shall settle from the influent as it flows to the periphery of the tank. At the periphery of the tank, decant lines shall be provided at three elevations for the clarified liquid.
   2. A central drive mechanism shall rotate a center cage supporting two rake arms. The rake arms shall be equipped with scraper blades and shall direct settled solids to the sludge pocket.

1.04 SUBMITTALS

A. Shop Drawings and Product Data: Submit complete Shop Drawings, including output torque and gear and bearing life calculations, for the Clarifier in accordance with Section 11005.
   1. In accordance with AGMA 2001-C95 calculations shall clearly present the values used for the following design Parameters:
      a. Number of Pinions.
      b. Actual face width.
      c. Tooth Geometry (I and J factors).
      d. Load distribution factor.
      e. Allowable contact stress.
      f. Allowable bending stress.
      g. Hardness ratio factor.
      h. Elastic coefficient.
      i. Stress cycle factor.
   2. The load distribution factor shall be determined by the empirical method. For parameters which are material dependent, such as allowable contact stress, the

calculations shall include a complete description of material and heat treatment used.

B. Installation, Operation and Maintenance (IO&M) Manuals: Submit IO&M Manuals for Clarifiers in accordance with Section 11005.

C. Certificates: Submit Certificates for the Clarifier installation in accordance with Section 11005 from the equipment manufacturer, or from the manufacturer's qualified, factory-authorized representative, attesting that the installed equipment has been inspected, adjusted, approved, and certified to be satisfactory prior to Initial Mechanical Performance Testing.

1.05 QUALITY ASSURANCE

A. Manufacturer's Representative: Provide the services of a qualified, factory-authorized, manufacturer's representative to perform the services specified in Section 11005 and for the required man-days as specified herein.
   1. Initial Operation and Initial Mechanical Performance Test (IMPT): Provide a minimum of one man-day for performance of the work of Initial Operation and Initial Mechanical Performance Test as specified in Section 11005.
   2. Training: Provide a minimum of one man-day, pursuant to satisfactory completion of the IMPT, for hands-on training of the Owner's personnel. Training shall include, but not be limited to, the following:
      a. Start-up and shut-down procedures.
      b. Equipment adjustments.
      c. Troubleshooting.
      d. Review of the equipment Operation and Maintenance Manual. This portion of the training is to include classroom instruction, along with detailed discussions of the components and subsystems equipment.
      e. Supervision of the Owner's operating personnel during total system operation.
      f. Preventive maintenance scheduling and procedures.

B. Manufacturer's Experience Qualifications: The equipment manufacturer shall certify to not less than ten years of experience in the application, design and manufacturer of clarifier equipment of the type specified in this Section. The equipment manufacturer shall produce a list of not less than ten operating installations of its clarifiers in wastewater treatment plants as evidence of meeting the experience requirement.

C. Equipment System Responsibility: The Contractor shall obtain clarifier equipment and thickener equipment specified under Section 11344 – "Gravity Thickeners" including motors, drives, control and appurtenances from one supplier. Vested responsibility for designing, coordinating and furnishing the equipment and for initial operation and control adjustments shall be that of the manufacturer or of the manufacturer's qualified, factory authorized representative.

D. Requirements of Regulatory Agencies: Comply with construction requirements of State, County, and such other local political subdivision specifications as may exceed the requirements of the codes, standards, and approving bodies referenced herein.
   1. Comply with requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels and Certifications and the National Electrical Manufacturers' Associations (NEMA) Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the Equipment.
   2. Provide Electrical Control panels constructed in accordance with the practices and requirements of the Underwriters' Laboratories, or other nationally recognized certification agency, with the appropriate certification label installed.

E. Basis of Design: Drawing layout and Specifications are based on Envirodyne Systems, Inc. clarifier equipment. Any costs resulting from changes to structure, piping, electrical work, plumbing work, etc., required for another clarifier manufacturer, borne by Contractor. Submit drawings to Engineer for approval, showing changes in equipment, piping, structure, electrical work, and plumbing work.

F. Certificates and Permits: Upon completion of work, and prior to final payment, furnish to the Engineer formal certification of final inspections from authorities having jurisdiction and secure required permits, if any, from such authorities. Additionally, prepare detailed diagrams and drawings which may be required by those authorities having jurisdiction.

G. Equipment Compatibility: Where like items of equipment are incorporated into equipment systems (i.e. two clarifiers) such items shall be identical.

H. 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, that is, items having both primer and final finish coatings, except as specified in Section 09900.

1.06 DELIVERY, STORAGE AND HANDLING

A. General Requirements: In addition to requirements for materials handling and storage as stated in the General Conditions of the Contract, the following applies:
   1. When unloading the Clarifier materials, equipment and machinery provide special lifting harness or apparatus as may be required by manufacturer. Handle the materials, equipment and machinery in accordance with manufacturer's written instructions.
   2. Store the materials, equipment and machinery, both on and off site, in accordance with manufacturer's written instructions.
   3. When transporting the materials, equipment and machinery both on site and from Contractor's storage to the site, do so in accordance with recommendations of the manufacturer.

PART 2 PRODUCTS

2.01 BASIC MATERIALS

A. Concrete Tank Materials: As specified in Section 03300.

B. Grout for Tank Bottom: As specified in Section 03600.

C. Anchors and Fasteners: Anchor bolts and fasteners as specified in Section 05500. Provide anchor bolts and fasteners in AISI Type 316 stainless steel and of sizes recommended by the clarifier mechanism manufacturer.

D. Clarifier Bridge and Walkway Railing: As specified in Section 05600 for Welded Aluminum Pipe Railings. Provide railing with toeplate.

2.02 MANUFACTURED CLARIFIER UNIT

A. Acceptable Manufacturers:
1. Envirodyne Systems, Inc.
2. US Filter, Envirex Products.
3. Eimco Process Equipment Company, Inc.
4. WesTech Engineering, Inc.

B. Phase One Construction - Basic Materials and Design Requirements
1. Design Criteria – Phase One Clarifiers:

	Clarifier No. 1	Clarifier No. 2*
Influent, gpm		
minimum	40	40
design	8,815	8,815
maximum	20,833	20,833
Solids loading (lb/ft^2-day)		
minimum	0.06	0.06
design	0.5	17.7
maximum	7.1	94.1
Tank Diameter	60	60
36" Pipe Influent El.	729.75'	729.75'
Side water depth (ft.)	14	14
Freeboard	2	2
Bottom slope (in./ft.)	1	1

*Clarifier No. 2 for Phase 2 construction has the same solids loading rate and torque ratings as Clarifier No. 1.

2. Drive Continuous Torque:
   a. Clarifier No. 1: 13,000 foot-pounds minimum.
   b. Clarifier No. 2: 36,000 foot-pounds minimum.*
3. Drive Momentary Peak Torque:
   a. Clarifier No. 1 26,000 foot-pounds minimum.

b. Clarifier No. 2 72,000 foot-pounds minimum.*

4. Steel: ASTM A36 quality and minimum ¼ inch thickness, except as indicated for greater thicknesses. Shop-grind edges to a radius to ensure satisfactory coating adherence.
   a. All welding to conform to American Welding Society Standard AWS D1.1. Structural support members shall be shop welded for bolted field assembly. Field welding shall be limited to bridge splices and tack welding of skimmer connections after final positioning.
   b. Design components so that stresses developed do not exceed allowable stresses, as defined by current AISC standards when designed for the AGMA rated torque.
   c. Panel lengths and member sizes shall be selected such that slenderness ratios do not exceed 200 for compression and 240 for tension. For strength, the controlling member force shall be used to determine member size.
   d. Maximum deflection in a span under combined live and dead loads shall not exceed L/360.
5. Structurally and mechanically design the unit to sweep at least two inches of grout on the tank bottom under its own power. Grout materials and mix proportions as specified in Section 03600.

C. Drive Unit:
1. Design Parameters:
   a. The drive unit shall be manufactured by the clarifier equipment supplier to ensure unit responsibility. The drive unit shall be designed for the torque values previously listed. It shall turn the mechanism at the designed collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L-10 life of 50 years, or 450,000 hours. The drive unit shall be capable of producing and withstanding the previously listed momentary peak torque while starting. The drive gear shall be designed to a minimum AGMA 5 rating when rated in accordance with AGMA 2001-B88. The main bearing shall be capable of withstanding the listed overturning moment without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.
   b. All gearing shall be designed per AGMA standard 2001-B88 for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the two values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled.
   c. No overturning pinions shall be allowed on the speed reducing unit. The lower pinion shall not be located below the turntable base.
2. Physical Characteristics: The drive unit shall consist of a solid internal main gear, turntable, pinion, secondary speed reducer, support base, and drive unit bearing. The drive shall be mounted on the center column and support the entire rotating load of the mechanism. The main internal gear shall be forged of alloy hardened steel. The pinion shall be heat treated alloy steel. All speed reducers shall be fully enclosed and running in oil or grease. Support base for the drive shall of welded steel to assure rigidity. Oil and dust shields shall be provided. The drive

bearing shall include forged steel precision gear/bearing set, with fully contoured raceways hardened to a minimum 58-60 Rc. The drive shall be designed so that the balls can be easily replaced without removing the access walkway. The main gear and pinion shall run in an oil bath or be grease lubricated. If an oil bath is used, an oil sight glass, fill pipe, and drain line shall be provided for the reservoir. Lubrication fittings shall be readily accessible.

3. Overload Protection: An overload device shall be provided in a stainless steel, weatherproof enclosure. The device shall be actuated by torque from the rotation of the secondary speed reducer, which shall operate two independently adjustable switches (the alarm switch at 100 percent of the design running torque and the motor cutout at 120 percent of the design running torque). These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indication shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque.
4. Turntable: The turntable base shall have an annular raceway for a ball race upon which the rotating assembly rests. It shall have a maximum allowable deflection in accordance with the bearing specifications. The allowable modulus of elasticity shall be a minimum of 29×10^6 psi. The center cage shall be fastened to and supported from the gear casing. Ball bearings shall be of the highest quality high carbon chrome alloy steel running in fully contoured races, as part or a precision gear/bearing set. The balls shall be grease lubricated and protected by elastomer seals.
5. Speed Reducing Unit:
   a. The speed reducing unit shall consist of cycloidal or helical speed reducers directly connected to a motor without the use of chains or v-belts and shall be keyed to the pinion.
   b. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft.
   c. Speed reducer helical gearing shall be manufactured to AGMA standards. The speed reducer shall have a service factor of 1.25.
   d. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and run in a totally submerged oil bath or be grease lubricated.
6. Motor: Motors shall be 1800 RPM, squirrel cage, induction type, TEFC, ball bearing heavy duty units of ample power for starting and operating the mechanism without overload, with a service factor of 1.15. A motor canopy shall be provided on the rake drive. Power supply to the equipment shall be 240/460 volt, 60 hertz, 3 phase.

D. Center Column:

1. Cylindrical steel column of 1/4 inch minimum wall thickness. Center column sized to support the drive mechanism, bridge and walkway, withstand full torque developed by the drive mechanism without transmitting torque to the walkway, serve as a clarifier influent pipe allowing unrestricted flow into the influent well. Fabricate the column to accommodate tank structural design indicated on the Drawings.
2. The column base shall have a support flange of 1-1/4 inch minimum thickness steel for bolting to the foundation with a minimum of eight 1-1/4 inch diameter anchor bolts as indicated on the Drawings. A similar flange shall be provided at the top of the column for supporting and securing the center dive assembly.
3. Provide inlet ports at the upper end of the column to diffuse the flow of the clarifier influent to ensure low velocity into the influent well. Influent velocity shall be reduced by providing a column port area of not less than 135 percent of the column area.
4. Provide an access port of 16 inch square clear opening, at the base of the column. Provide the port with a gasketed cover secured with AISI Type 316 stainless steel bolts.

E. Center Cage: Complete shop welded steel box truss construction bolted to the drive mechanism and designed to support and rotate the influent well, rake arms and skimmer. Cage design shall be such that calculated stresses do not exceed the AISC allowable stress at twice the specified drive continuous torque. Cage design shall also allow removal and replacement of the center column access port cover without disassembly of any truss members. Provide steel deflector plates to dissipate the velocity of the influent flow.

F. Walkway and Bridge (Center Platform): Provide structural steel frame bridge type construction designed to support a uniform live load of 50 pounds per square foot plus dead load over the entire span with a maximum deflection of 1/360, and provide a minimum three feet clearance between pipe railing, and two feet minimum clearance all around drive mechanism.
   1. Provide 3-feet 6-inches height handrailing with intermediate rail and toeplate, installed around entire walkway and platform. Provide walkway surface grating, platform checker plate, pipe railing and toeplate constructed of aluminum.
   2. A center drive platform shall be provided which allows 24" clearance outside the center drive components.
   3. Aluminum materials and finishes as specified in Section 05600.

G. Influent Well: 3/16-inch steel plate construction, concentric with and surrounding the center cage to diffuse influent into the clarifier. Influent well shall be of adequate size to diffuse the flow in the tank at a uniform velocity. Support by structural members from the center cage.

H. Rake Arms: The mechanism shall include two rake arms of steel truss construction with steel scraper blades and adjustable squeegees, conforming to the slope of the tank bottom, rigidly connected to the center cage. Squeegees shall be fastened to the rake blades with stainless steel fasteners. Tie rod supports are not acceptable. Design rake

arms such that calculated stresses do not exceed the AISC allowable stress at twice the specified drive torque. Space the blades so the entire tank bottom is swept twice per revolution. The blades shall rake the sedimentation to a center hopper. The arms shall be adjustable at the cage to assure an even grout thickness over the tank bottom. Vertical pickets of structured steel angle shall be attached to the rake arms on 2'-0" centers.

PART 3 EXECUTION

3.01 INSTALLATION

A. Refer to manufacturer's instruction and installation material before proceeding with installation of equipment. Install the collector mechanisms in accordance with equipment manufacturer's instructions.

B. *Concrete* Tank Floor Grouting: As specified in Section 03600.

C. Clarifier Walkway and Bridge Railing Installation: As specified in Section 05600.

D. Clarifier Equipment Installation: As specified in Section 11005.

3.02 TESTING AND STARTUP

A. Torque Test: The entire sludge collector mechanism shall be statically load tested by individually loading each take arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. Each arm drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating hot the torque will be applied prior to the test taking place.

B. Operation Test: The mechanism shall be operated in a dry tank for a minimum of 6 continuous hours before flow is allowed to enter the system. There shall be no binding, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 6 hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be replaced and the test re-run.

END OF SECTION

SECTION 11344

GRAVITY THICKENER

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for a half bridge type gravity thickener unit(s) including the drive, scraper arms, weir plates and accessories as indicated on Drawings for removing sludge from circular process units. One (1) thickener mechanism is to be furnished for each of the Phase 1 and Phase 2 construction projects.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Cast-In-Place Concrete: Section 03300.
   3. Grouts: Section 03600.
   4. Metal Fabrications: Section 05500.
   5. Aluminum Fabrications: Section 05600.
   6. Paints and Coatings: Section 09900.
   7. Basic Equipment Materials and Methods: Section 11005.
   8. Division 16: Electrical.

1.02 REFERENCES

A. American Gear Manufacturers Association (AGMA):
   1. AGMA 6034-B92, Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors.
   2. AGMA 2101-C95, Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.

B. American Institute of Steel Construction (AISC).

C. American Bearing Manufacturers Association (ABMA).

D. American National Standards Institute (ANSI).

E. Institute of Electrical and Electronics Engineers (IEEE).

F. National Electrical Manufacturers Association (NEMA).

G. American Iron and Steel Institute (AISI).

H. British Standard 721:1963, governing Worm and Worm Gear Design.

I. Occupational Safety and Health Administration (OSHA).

1.03 SYSTEM DESCRIPTION

A. Sludge Thickeners:
   1. Description of Operations: Wastewater clarifier sludge blowdown, sedimentation basin sludge and belt filter press filtrate enter thickener through an influent pipe. Influent flow is intermittent. Influent enters feed well designed to prevent short circuiting, dissipate energy and distribute influent flow radially downward. Flow will continue to periphery of tank where it is collected in a continuous circular launder. In order to accommodate an increase the plant capacity from 20 mgd to 30 mgd a second phase of construction is required in which a second thickener shall be provided.
   2. A central drive mechanism rotates a center torque shaft supporting two rake arms with pickets at approximately two revolutions per hour. Scraper blades attached to the arms direct solids to the sludge pocket at the center for discharge. The tank bottom is scraped twice per hour.
   3. Thickener design criteria:

	Thickener No. 1 (Phase 1)	Thickener No. 2 (Phase 2)
Thickener Influent, gpm		
minimum	125	125
design	2305	1505
maximum	2305	1505
Overflow, gpm		
minimum	125	125
design	1905	1305
maximum	1905	1305
Solids loading (lb/ft^2-day)		
minimum	0.35	0.35
design	5	5
maximum	26.5	26.5
Solids Concentration		
Max. Influent Feed, %	2	2
Max. Sludge Blowdown, %	8	8
Tank Diameter, feet	113	80
Side water depth	22.50	22.50
Freeboard	2	2
Bottom Slope (in./ft.)	4	4

   4. Influent feed well with side feed connections.
   5. Full bridge to support scraper drive mechanism, influent feed well, walkway and influent pipe.
   6. Drive mechanism to rotate suspended center torque shaft with two attached scraper arms and pickets.
   7. Collector mechanism.

B. Design the thickener mechanisms, including scraper arms, influent feed well, center cage and drive mechanism for the following conditions:

1. Sludge characteristics: Sludge from a potable water treatment plant consisting of varying amounts of solids from a river supply, powdered activated carbon, coagulant, and polymers.**Following is an example - Engineer to Revise**
2. Chemical conditioning: High molecular weight polymers.
3. Sludge storage to a side water depth of 22.5 feet for sludge thickener.
4. Minimum 20-year continuous operating torques:
   a. Thickener No. 1: 130,000 ft.-lbs.
   b. Thickener No. 2: 65,000 ft.-lbs.
5. Minimum 20-year momentary peak torque:
   a. Thickener No. 1: 260,000 ft.-lbs.
   b. Thickener No. 2: 130,000 ft.-lbs.
6. Output speed 2.4 RPH.

C. The continuous operating and momentary peak torque rating shall be established by the American Gear Manufacturers Association (AGMA) criteria specified herein. The over-all rating of the drive mechanism shall be the lowest rating of the worm gear, worm, spur gear or pinion.

D. Design and rate the worm gear and worm including the motorized worm gear primary speed reducer and the intermediate reduction worm gear reducer in accordance with AGMA 6034-B92 and British Standard 721:1963.
   1. Class I AGMA load classification service factor of 1.25 for 24 hr/day, uniform load duty.
   2. Furnish calculations and the following data to substantiate the continuous operating and peak momentary output torque ratings of the primary and intermediate worm gear speed reducer:
      a. Worm Gear Pitch Diameter, D.
      b. Worm Gear Effective Face Width, Fe.
      c. Mean Worm Diameter, d.
      d. Materials of Construction including hardness.
      e. Ration Correction Factor, KM, including the number of worm gear teeth and number of threads in worm.
      f. Materials Factor, Ks, including the casting method.
      g. Velocity Factor, Kv, including the mean worm diameter sliding velocity, number of leads, and worm circular pitch.
   3. Furnish a sworn certificate that AGMA design criteria have been complied with.

E. Design and rate spur gear and pinion in accordance with AGMA 6037-C95 and British Standard 721:1963 for continuous 24 hour duty at the specified life and torque.
   1. Furnish the following data:
      a. Gear Material and Brinnell Hardness.
      b. Pitch Diameter.
      c. Number of Teeth.
      d. Diametral Pitch.
      e. Tooth For-in.
      f. Tooth Face Width.

2. Furnish justification of all assumptions, variables and parameters used to determine the following factors:
   a. I and J geometry factors.
   b. Allowable bending stress, Sat.
   c. Allowable contact stress, Say.
   d. Allowable yield stress, Say.
   e. K1 and C1 life factors.
   f. Km and Cm load distribution factors.
   g. Ch hardness ratio factor.
   h. Cp elastic coefficient.
   i. Ks and Cs size factors.
   j. Cf surface condition factors.
   k. Kf stress correction factor.
   l. Kv and Cv dynamic factors.
   m. Ka and Ca application factors.
   n. Cr and Kr factor of safety to be based on fewer than 1 failure in 100.
   o. Kt and Ct temperature factors to be based on oil or gear blank temperatures below 250 degrees Fahrenheit.
   p. Ky factor based on Industrial Practices.
3. Furnish a sworn certificate that AGMA design criteria have been complied with.

F. Amply proportioned structural members for all stresses to which they may be subjected in erection or operation in accordance with the AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Building.
   1. Design load for rotating structural members including rotating center torque shaft, scraper arms and similar members, Two times the continuous operating torque plus dead loads.
   2. Design loads for center column, walkway, drive platform and walkway supports, either trusses or beams, live load of 100 pounds per square foot plus dead loads with a maximum allowable deflection of 1/360 of the span.
   3. Design compression members so that loadings do not exceed AISC L/R slenderness ratio criteria.
   4. Furnish a sworn certificate that AISC design criteria have been complied with.

G. Design all bearing based upon a uniform distributed load of rotating mechanism in accordance with applicable provisions of the latest Standards of the ABMA and the ANSI Method of Evaluating Load Ratings for Ball and Roller Bearings.
   1. Main spur gear bearings
      a. Minimum diameter of ball race sufficient to provide adequate stability against overturning of the mechanism but not less than 42 inches.
   2. All other bearings including pinion and thrust bearings.
      a. Minimum B-10 Rating Life not less than 20 years of continuous 24-hour duty.

H. Accessories:
   1. Set bases at proper location, elevation and alignment, and level.

2. Provide all steel members with a minimum thickness of 1/4-inch, except as otherwise specified.
3. Where specified, provide Meehanite casting for gears conforming to Class 40-45; GF40 Meehanite.
4. Use Type 304 stainless steel anchor bolts, nuts and washers.

1.04 SUBMITTALS

A. Furnish the Engineer with manufacturer's certificate regarding equipment installation prior to initial operation and mechanical performance test.

B. Shop Drawings and Product Data:
   1. Submit in accordance with these Specifications and complete working, detail, dimension, assembly and installation drawings, catalog and other data and manufacturers specifications.
      a. Indicate materials of construction and installation, parts, finishes, piping and accessories.
      b. Indicate foundation or mounting requirements, anchors, supports and connections.
      c. Indicate motors, conduits, both internal and external wiring, and equipment.
         1) Include point to point wiring diagrams.
      d. Indicate size and location of all necessary floor, wall and ceiling openings, sleeves and castings.
      e. Include a tabulated list of motors and electrical devices:
         1) Ampere and voltage operating characteristics for all devices.
         2) For motors 1/2 horsepower and larger: full load amperes, locked rotor torque, power factor, efficiencies, slip and temperature rise.
   2. Calculations confirming output torque ratings of drive mechanisms proposed for use.
   3. Submit in accordance with these Specifications and Section 11005 manufacturers' descriptive literature and specifications covering the product specified. Include installation information, component parts, drawings, motor data, operating and maintenance instructions, etc.
      a. Include operating procedure, lubrication and maintenance requirements of all equipment furnished.
      b. Include wiring diagrams, drawings, cuts, ;parts lists, troubleshooting guide and other necessary data.
      c. Number or otherwise clearly identify all parts to facilitate ordering of replacements.

C. Certificates: Submit in accordance with these Specifications certified records or reports of results of shop tests; such records or reports to contain a sworn statement that shop tests have been made as specified, and that materials and construction are in compliance with these Specifications.
   1. Torque rating certification and torque test procedure with shop drawings.

1.05 QUALITY ASSURANCE

A. General: Comply with provisions of Section 11005.

B. Basis of Design: The drawings and specifications are based on Envirodyne Systems, Inc. thickener equipment. Any costs resulting from changes to the structure, piping, electrical work etc. required for equipment supplied by others shall be born by the Contractor. The Contractor shall submit drawings to the Engineer for approval, showing proposed changes in the structure, piping, equipment, electrical work etc.

C. Responsibility: To ensure that all the equipment required for the installation of the thickener equipment is properly coordinated and will function in accordance with the intent of these Specifications, obtain all the equipment specified under this Section and also specified under Section 11336 – "Clarifiers" from a single supplier in whom the responsibility for the proper function of all the equipment as an integrated and coordinated system shall be vested. The intent of this paragraph is to establish unit responsibility for all the equipment with the equipment supplier. The use of the word "responsibility" relating to the thickener and clarifier equipment supplier is in no way intended to relieve the Contractors ultimate responsibility for equipment coordination, installation, operation and guarantee.

D. Manufacturers Experience: Consideration will be given only to products of manufacturers thoroughly experienced in the design and manufacture of equipment of the type and capacity contemplated herein and who have had at least 5 installations in continuous satisfactory use for at least 5 years in service similar to that intended.

E. Erection Qualifications: Install gravity thickener and control with skilled erection labor in accordance with manufacturer's written instructions. Consult manufacturer's representative during installation.

F. Requirements of Regulatory Agencies: The construction code requirements of State, County or other political subdivision which exceed the requirements of national codes, standards and approving bodies shall be met and complied with.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle the thickener drive mechanisms and motors in accordance with these Specifications. In the event of damage, make repairs or replacements at no increase in Contract Price.

B. Unload, store and protect the equipment in strict accordance with manufacturers written instructions.

1.07 PROJECT CONDITIONS

A. Provide workmanship which is first class in every respect.
   1. Have installation performed by workmen thoroughly experienced in such work.
   2. A neat and workmanlike appearance in the finished work will be required.

B. Provide work in accordance with pertinent laws, codes, and regulations.

C. Install per manufacturers recommendations.

1.08 MAINTENANCE

A. Extra Materials: Provide the following extra materials, suitably packaged for long term storage, and legibly marked as to the package contents.
   1. One worm gear shaft for each size drive mechanism.
   2. One set oil seals for each collector drive.
   3. One set worm shaft bearings for each size drive mechanism.
   4. One complete drive chain for each size drive mechanism.
   5. Five squeegees with nuts and bolts.
   6. Eight shear pins.
   7. One set of overload control device switches.

PART 2 PRODUCTS

2.01 SLUDGE THICKENERS

A. Drive Mechanism
   1. Design Parameters:
      a. The drive unit shall be manufactured by the clarifier equipment supplier to ensure unit responsibility. The drive unit shall be designed for the torque values previously listed. It shall turn the mechanism at the designed collector tip speed. The drive main bearing shall be designed for the total rotating mechanism loads with a minimum L-10 life of 50 years, or 450,000 hours. The drive unit shall be capable of producing and withstanding the previously listed momentary peak torque while starting. The drive gear shall be designed to a minimum AGMA 5 rating when rated in accordance with AGMA 2001-B88. The main bearing shall be capable of withstanding the listed overturning moment without the aid of any underwater guides or bearings to ensure correct tooth contact for AGMA rating of the main gear.
      b. All gearing shall be designed per AGMA standard 2001-B88 for strength and surface durability, based on a life of 175,000 hours. The design running torque rating of the drive gearing shall be based on the smaller of the two values determined from the above AGMA standard. To ensure safety and ease of maintenance, all components of the drive shall be direct coupled.
      c. No overturning pinions shall be allowed on the speed reducing unit. The lower pinion shall not be located below the turntable base.
   2. Physical Characteristics: The drive unit shall consist of a solid internal main gear, turntable, pinion, secondary speed reducer, support base, and drive unit bearing. The drive shall be mounted on the center column and support the entire rotating load of the mechanism. The main internal gear shall be forged of alloy hardened steel. The pinion shall be heat treated alloy steel. All speed reducers shall be fully enclosed and running in oil or grease. Support base for the drive shall of welded steel to assure rigidity. Oil and dust shields shall be provided. The drive

bearing shall include forged steel precision gear/bearing set, with fully contoured raceways hardened to a minimum 58-60 Rc. The drive shall be designed so that the balls can be easily replaced without removing the access walkway. The main gear and pinion shall run in an oil bath or be grease lubricated. If an oil bath is used, an oil sight glass, fill pipe, and drain line shall be provided for the reservoir. Lubrication fittings shall be readily accessible.

3. Overload Protection: An overload device shall be provided in a stainless steel, weatherproof enclosure. The device shall be actuated by torque from the rotation of the secondary speed reducer, which shall operate two independently adjustable switches (the alarm switch at 100 percent of the design running torque and the motor cutout at 120 percent of the design running torque). These two switches shall be factory adjusted to accurately calibrate the alarm torque value and the overload position. A visual torque indication shall be provided and oriented so that it may be read from the walkway. It shall be calibrated from 0 to 160 percent of design running torque.
4. Turntable: The turntable base shall have an annular raceway for a ball race upon which the rotating assembly rests. It shall have a maximum allowable deflection in accordance with the bearing specifications. The allowable modulus of elasticity shall be a minimum of 29×10^6 psi. The center cage shall be fastened to and supported from the gear casing. Ball bearings shall be of the highest quality high carbon chrome alloy steel running in fully contoured races, as part or a precision gear/bearing set. The balls shall be grease lubricated and protected by elastomer seals.
5. Speed Reducing Unit:
   a. The speed reducing unit shall consist of cycloidal or helical speed reducers directly connected to a motor without the use of chains or v-belts and shall be keyed to the pinion.
   b. The main ring gear of cycloidal drives shall be made of high carbon chromium bearing steel and be fixed to the drive casing. An eccentric bearing on the high speed shaft shall roll cycloidal discs of the same material around the internal circumference of this main ring gear. The lobes of the cycloid disc shall engage successively with pins in the fixed ring gear. The movement of the cycloid discs shall be transmitted then by pins to the low speed shaft.
   c. Speed reducer helical gearing shall be manufactured to AGMA standards. The speed reducer shall have a service factor of 1.25.
   d. The reducers shall be fitted with radial and thrust bearings of proper size for all mechanism loads and run in a totally submerged oil bath or be grease lubricated.
6. Motor: Motors shall be 1800 RPM, squirrel cage, induction type, TEFC, ball bearing heavy duty units of ample power for starting and operating the mechanism without overload, with a service factor of 1.15. A motor canopy shall be provided on the rake drive. Power supply to the equipment shall be 240/460 volt, 60 hertz, 3 phase.

B. Center Column:
   1. Cylindrical steel column of 1/4 inch minimum wall thickness. Center column sized to support the drive mechanism, bridge and walkway, withstand full torque developed by the drive mechanism without transmitting torque to the walkway, serve as a clarifier influent pipe allowing unrestricted flow into the influent well. Fabricate the column to accommodate tank structural design indicated on the Drawings.
   2. The column base shall have a support flange of 1-1/4 inch minimum thickness steel for bolting to the foundation with a minimum of eight 1-1/4 inch diameter anchor bolts as indicated on the Drawings. A similar flange shall be provided at the top of the column for supporting and securing the center dive assembly.
   3. Provide inlet ports at the upper end of the column to diffuse the flow of the clarifier influent to ensure low velocity into the influent well. Influent velocity shall be reduced by providing a column port area of not less than 135 percent of the column area.
   4. Provide an access port of 16 inch square clear opening, at the base of the column. Provide the port with a gasketed cover secured with AISI Type 316 stainless steel bolts.

C. Center Cage: Complete shop welded steel box truss construction bolted to the drive mechanism and designed to support and rotate the influent well, rake arms and skimmer. Cage design shall be such that calculated stresses do not exceed the AISC allowable stress at twice the specified drive continuous torque. Cage design shall also allow removal and replacement of the center column access port cover without disassembly of any truss members. Provide steel deflector plates to dissipate the velocity of the influent flow.

D. Walkway and Bridge (Center Platform): Provide structural steel frame bridge type construction designed to support a uniform live load of 50 pounds per square foot plus dead load over the entire span with a maximum deflection of 1/360, and provide a minimum three feet clearance between pipe railing, and two feet minimum clearance all around drive mechanism.
   1. Provide 3-feet 6-inches height handrailing with intermediate rail and toeplate, installed around entire walkway and platform. Provide walkway surface grating, platform checker plate, pipe railing and toeplate constructed of aluminum.
   2. A center drive platform shall be provided which allows 24" clearance outside the center drive components.
   3. Aluminum materials and finishes as specified in Section 05600.

E. Influent Well: 3/16-inch steel plate construction, concentric with and surrounding the center cage to diffuse influent into the clarifier. Influent well shall be of adequate size to diffuse the flow in the tank at a uniform velocity. Support by structural members from the center cage.

F. Rake Arms: The mechanism shall include two rake arms of steel truss construction with steel scraper blades and adjustable squeegees, conforming to the slope of the tank

bottom, rigidly connected to the center cage. Squeegees shall be fastened to the rake blades with stainless steel fasteners. Tie rod supports are not acceptable. Design rake arms such that calculated stresses do not exceed the AISC allowable stress at twice the specified drive torque. Space the blades so the entire tank bottom is swept twice per revolution. The blades shall rake the sedimentation to a center hopper. The arms shall be adjustable at the cage to assure an even grout thickness over the tank bottom. Vertical pickets of structured steel angle shall be attached to the rake arms on 2'-0" centers.

G. Launder: A rectangular effluent launder shall be provided around the perimeter of the tank. The launder shall be formed as a part of the concrete wall.

H. Controls and Wiring:
   1. Provide all external wiring, conduits, disconnects and motor starters under Division 16.

I. Acceptable Manufacturers:
   1. Thickener:
      a. WesTech Engineering, Inc.
      b. Envirodyne Systems, Inc.
      c. U.S. Filter, Envirex Products
      d. Eimco Process Equipment Company, Inc.
   2. Motor:
      a. U.S. Electrical Motors.
      b. General Electric Company.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine equipment and components for damage or loss. Inform Engineer of damage, loss, or defects. Do not proceed with installation until damage, loss or defects have been corrected.

3.02 PREPARATION

A. Field Measurement
   1. The Drawings are generally indicative of the work, but are not an exact representation of all conditions involved; therefore, lay out piping, equipment, anchors, etc., to suit actual field measurements. No extra compensation will be made for work due to differences between indicated and actual dimensions.
   2. Submit details of proposed departures necessitated by field conditions or other causes to the Engineer for approval.

3.03 INSTALLATION

A. Refer to manufacturer's instruction and installation material before proceeding with installation of equipment. Install the collector mechanisms in accordance with equipment manufacturer's instructions.

B. After installation and alignment of mechanism, place and finish 2 inches of grout with screeds attached to the collector.
   1. Grout in accordance with Division 3.
   2. Obtain the services of the equipment supplier to instruct and supervise the screeding operation until the Contractor is proficient with the operation, but at least for one mechanism.
   3. As a minimum, use the following procedure in the screeding operation.
      a. Provide the structural concrete base with a broom finish in accordance with Division 3.
      b. Thoroughly clean the walls and floors with clean brooms and flushing with a strong jet of water or other appropriate means to remove all sludge, scum, grease, dirt, trash and other foreign matter.
      c. Thoroughly wet the floor at least 12 hours before placing grout.
      d. Immediately before placing grout remove all pools and puddles of water and broom into the surface a 1/16 to 1/8-inch thick coat of neat-cement paste or slurry.
      e. Attach screed boards to the scraper blades. Do not use squeegees supplied with mechanism to screed grout. The bottom of the screed shall be beveled up in the direction of travel and fitted with a light gage sheet metal shield. Provide a minimum of 2 inches of clearance at any point between the screed board and the rough slab.
      f. Hand trowel area from center to outer edge of sump and the periphery of tank.
      g. Continuously run the mechanism during the placing operation and take necessary precautions not to damage mechanism.
      h. Run the mechanism several revolutions after placing grout to ensure an even and smooth surface.
      i. Cure and protect the grout in accordance with Division 3 except as modified herein. After grout has hardened sufficiently but not more than 12 hours after the grout is placed, fill the tank with water to submerge the entire floor.
      j. After 7 days of submergence, drain tank and install squeegees.

3.04 TESTING AND STARTUP

A. Torque Test: The entire sludge collector mechanism shall be statically load tested by individually loading each take arm with 150 percent of the specified design running torque. The test shall verify the torque overload control device settings for alarm and motor cutout. Each arm drive unit's ability to withstand the specified torque. Sketches and calculations shall be submitted illustrating hot the torque will be applied prior to the test taking place.

B. Operation Test: The mechanism shall be operated in a dry tank for a minimum of 6 continuous hours before flow is allowed to enter the system. There shall be no binding, or unusual motion exhibited during this run in period. Motor amperage shall be checked at least hourly for any unusual or higher than normal figures. After the unit has successfully passed this initial test, flow shall be introduced into the tank and the same 6 hour observation test run. If the unit should fail under any of these conditions, the test shall be halted and the problem corrected. If, after several attempts, the unit does not successfully pass the field test, the faulty portion of the equipment shall be replaced and the test re-run.

3.05 PAINTING

A. Prepare the surfaces, shop prime and apply other protective coatings surfaces prior to delivery where specified in accordance with Section 09900, Painting. Furnish only primers which are compatible with finish coat.

B. Field painting will be performed under Section 09900, Painting.

END OF SECTION

SECTION 11361

BELT FILTER PRESS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for three (3) sludge dewatering belt filter presses to be located in the Residuals Dewatering Building as indicated on Drawings. Two (2) of the belt filter presses and accessories are to be furnished for Phase 1 construction and one (1) belt filter press and accessories are to be furnished for Phase 2 construction.

B. Equipment furnished and installed under this section shall be fabricated, assembled, erected and placed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer

C. Related Sections:
   1. Submittal Procedures: Section 01300
   2. Products: Section 01600
   3. Testing: Section 01650.
   4. Paints and Coatings: Section 09900.
   5. Basic Equipment Materials and Methods: Section 11005.
   6. Division 16 - Electrical.

1.02 REFERENCES

A. Institute of Electrical and Electronic Engineers (IEEE).

B. National Electric Manufacturers Association (NEMA).

1.03 QUALITY ASSURANCE

A. General Requirements: Comply with provisions of Section 11005.

B. Basis of Design: Specifications are based on Klampress 2.0 meter belt filter press equipment as manufactured by the Ashbrook Corporation. Submit drawings to Engineer for approval.

C. Erection Qualifications: Install belt filter press equipment with skilled erection labor in accordance with manufacturer's written instructions. Consult manufacturer's representative during installation.

D. Requirements of Regulatory Agencies: Construction code requirements of State, County or other political subdivision which exceed requirements of national codes, standards and approving bodies to be complied with.

1.04 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings for belt filter press equipment in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications.

B. Furnish Engineer with manufacturer's certificate regarding equipment installation prior to initial operation and mechanical performance test.

C. Shop Drawings and Product Data:
   1. Submit in accordance with these Specifications and Section 11005, manufacturer's published detail drawings, modified to suit design conditions if required.
   2. Submit in accordance with these Specifications, manufacturer's descriptive literature and specifications covering product specified. Include installation information, pump component parts drawings, system head curves, motor data, operation and maintenance instructions, etc.

1.05 DESIGN CRITERIA

A. The sludge dewatering system shall consist of three (3) belt filter presses (two (2) for Phase 1 and one (1) for Phase 2) and all appurtenances. Each belt filter press shall be a complete prefabricated unit consisting of at least a sludge conditioning system, a gravity drainage section, a pressure section, a belt alignment and tensioning system and a belt washing system. Only units having a measured effective belt width of 2.0 meters shall be considered acceptable under this specification.

B. The overall static weight of the belt filter press shall not exceed 19,650 pounds

C. The sludge dewatering equipment shall be designed to adequately condition and dewater the sludge so that a dewatered sludge cake is produced that easily discharges from the dewatering unit without blinding and that may be handled by the conveying equipment.

D. Each unit shall be designed to operate in the environment for which it is intended, continuously or intermittently on demand, and shall perform the required dewatering operations without spillage of water or sludge beyond the nominal machine envelope.

E. Belt Filter Press Equipment:

Description	Belt Filter Press
General Pump Requirements	Settled river water with coagulant
Type of Sludge	from residuals thickener
Solids Concentration	
Influent	1.2%-5.5%
Effluent	20%

Design Points	
Hydraulic Capacity	200 gpm
Sludge Throughput	1200 lb/hr
Motor Requirements	
Voltage	460
Phase	3
Hz	60
Horsepower	3
RPM	1740
Enclosure	TEFC
Service Factor	1.15
Rating	Severe Duty
NEMA Design	B
Insulation Class	F

F. The manufacturer shall guarantee the above performance criteria, backed by a separate process performance bond or irrevocable letter of credit in the full amount of the equipment price, presented with the submission of engineering submittals. The manufacturer shall be allowed two opportunities to demonstrate compliance with the performance criteria. Should the equipment fail to meet the performance criteria after the second test, the manufacturer shall forfeit the bond or irrevocable letter of credit and remove the equipment.

1.06 DELIVERY, STORAGE AND HANDLING

A. Unload equipment with care. In event of damage make repairs or replacements at no increase in Contract Price. Follow manufacturer's instructions for unloading equipment.

B. Store and protect equipment in strict accordance with manufacturer's written instructions.

C. See Section 01600 for general handling, storage, and protection requirements.

PART 2 PRODUCTS

2.01 MATERIALS AND COATINGS

A. All materials used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM Standard Specification for Structural Steel, Designation A36/A36M. All iron castings shall conform to the ASTM Standard Specifications for Gray Iron Castings, Designation A48, and shall be of a class suitable for the purpose intended. Other materials shall conform to the ASTM Specifications

where such specifications exist and the use of such materials shall be based on continuous and successful use under similar conditions of service

B. All electrical components shall be U.L. listed where such listing exists and all electrical control panels shall be assembled in U.L. approved facilities. All structural carbon steel plates and shapes shall have a minimum thickness of 1/4 inch and shall be hot dip galvanized after fabrication in accordance with ASTM A-123.

C. Unless specified otherwise herein, all metals in contact with polyelectrolyte or sludge, and all other components specified to be stainless steel, shall be type 316L stainless steel.

D. The following materials and coatings shall be provided for the belt filter press and related components unless specified otherwise herein:

1.	Bearing housings	Nylon coated, cast iron
2.	Belt support grids	Stainless steel, 10 gauge fitted with UHMW polyethylene wiper bars
3.	Belt wash housing	Stainless steel, 14 gauge
4.	Belt wash spray tube and nozzles	Stainless steel
5.	Belt wash piping	Schedule 80 PVC, 1 1/2 inch
6.	Chicanes	Galvanized steel support rods, galvanized cast iron holders and U.H.M.W. polyethylene blades
7.	Chutes	Stainless steel, 10 gauge
8.	Doctor blades	U.H.M.W. polyethylene
9.	Drain trays	Stainless steel, 14 gauge
10.	Drain tray piping	Schedule 40 PVC
11.	Electrical junction box	Stainless steel or FRP
12.	Electrical conduit	SO Cord
13.	Electrical switch enclosures	NEMA 4X, press mounted
14.	Frame	A36 steel, hot dip galvanized, ASTM A123, minimum 3.9 mils
15.	Hardware, fasteners	316 stainless steel
16.	Hydraulic cylinders	
	Body	FRP tube with high strength glass filled nylon head
	Rod	Solid 316 stainless steel with hard surface treatment
17.	Miscellaneous	Carbon steel surfaces to be hot dipped galvanized per ASTM A123
18.	Polymer mixer housing	Cast 316ss
	Counterweight	Cast iron, galvanized
	Injection ring	UHMW polyethylene
	Splitter Manifold	UHMW polyethylene
19.	Rollers (solid)	Carbon steel, 1/2 -inch wall, with forged end piece including shaft and end plate. Drive rollers coated with Buna N rubber, 1/4 inch, other solid rollers coated with thermoplastic nylon, 25 mils

20.	Rollers (perforated)	1/4 –inch wall carbon steel hot dip galvanized, or nylon coated
21.	Roller shafts	Forged ASTM 572 Grade 50
22.	Sludge containment barriers	Stainless steel, 14 gauge

E. Other types of protective coatings shall not be acceptable. All hot dip galvanizing shall be applied in accordance with ASTM-A123. Zinc flame spray shall not be considered an acceptable substitute to this specification.

F. The heat setting thermoplastic nylon coating, specified herein, shall have the following properties:

Coating Properties	**Test Method**	**Value**
Hardness, Shore D	ASTM D-2240	77
Specific Gravity	ASTM D-792	1.06-1.20
Impact, RT & 45 F	ASTM D-2794 Direct Pass	160 in lbs
Tensile Strength	ASTM D-638	6000 PSI
Elongation	ASTM D-638	15%
Melting Point	ASTM D-789	370^0F
Abrasion Resistance (varies with color)	ASTM D-4060 CS17/1000/1000	8-18 mg. Wt. loss Taper Abrader)

Buna N rubber coating shall have the following properties:

Tensile strength, ASTM D-412	2500 psi
Tear strength, die C, ASTM D-624	250 psi
Elongation at break, ASTM D-412	160%
Hardness, Shore A, ASTM D -676	90

2.02 SLUDGE CONDITIONING SYSTEM

A. Each belt filter press shall be provided with a sludge conditioning system, designed to efficiently mix polymer with the sludge and to adequately condition the sludge, for optimum dewatering.

B. The sludge conditioning system shall be mounted upstream of the press and shall consist of an in-line, non-clog, static mixer with a variable orifice and a vortex polymer injection ring. The belt filter press manufacturer shall be required to provide, to the engineer, a proper layout for the system. The sludge conditioning system shall be capable of providing the following performance:
   1. The polymer and sludge must be instantly mixed (less than 1.0 seconds at 60 GPM).
   2. Mixing energy must be independently adjustable during operation.
   3. Flocculation time must be independently adjustable, by the displacement of flanged pipe sections, with the mixer, at a minimum of three locations in the sludge feed piping.

C. The manufacturer shall be required to demonstrate, during the start-up and calibration phase, that flocculation time can be adjusted by one man, within sixty minutes. The sludge conditioning system shall meet the following mechanical specifications:
   1. The in-line mixer shall have a flanged, cast housing, an adjustable orifice plate with shaft and O-ring seal connected to an externally mounted lever and counterweight and a removable side plate for inspection and cleaning.
   2. The open throat area shall be fully adjustable downward and shall open automatically to prevent clogging.
   3. The position of the counterweight on the externally mounted orifice plate lever shall be fully adjustable, within a 360 degree circle, to allow for adjustment of the mixing energy, regardless of the mounting angle, while the unit is in operation.

D. The polymer mixer shall be designed specifically for it's intended use. The use of modified check valves or mixers requiring electrical motors and controls shall not be acceptable to this specification.

2.03 STRUCTURAL MAIN FRAME

A. The structural main frame shall be fabricated of steel members conforming to AISC Standard Specifications for Structural Steel, into a rigid structure, adequately braced to withstand intended loads without excessive vibration or deflection

B. The frame shall have a minimum safety factor of ≥5 and maximum deflection of 0.025 inches under maximum loading. The moment of inertia of the structural members shall be adequately chosen to provide the safety factor and deflection rate specified herein.

C. Maximum load on the frame shall be based on the summation of forces applied to the frame from roller mass forces, weight of the rollers including the sludge and belts and belt tension forces. Belt tension forces shall include, but not be limited to, a belt tension of 50 pli per belt plus the tension produced by the driving torque of the motor at nameplate ph. Certified calculations, showing the frame to be in compliance with the specification, shall be submitted as set forth in the contract documents.

D. The framework shall be of welded and/or bolted construction. All welding shall conform to the American Welding Society Structural Welding Code.

E. The structure shall be designed for installation on a prepared concrete foundation and secured with anchor bolts. Permanent lifting lugs shall be provided as necessary to allow installation and removal of the belt filter press.

F. The construction shall allow easy access and visual inspection of all internal components.

G. The manufacturer shall warrant the frame and the coating for a period of three years from the date of start-up, not to exceed three and a half years from the date of delivery. The frame shall not require preventive maintenance during the warranty period. Any

defects or corrosion occurring within the warranty period shall be repaired or replaced at no additional cost to the owner.

2.04 GRAVITY DRAINAGE SECTION

A. Each belt filter press shall be furnished with a gravity drainage section to accept sludge from the sludge conditioning system. The gravity drainage section shall be furnished with a sludge feed chute and an inlet distributor to evenly distribute the conditioned sludge over the effective width of the moving filter belt.

B. The conditioned sludge shall be contained on the belt with adjustable containment barriers equipped with replaceable rubber seals to prevent leakage. Rubber seals are designed to be attached to the containment barriers, with a friction fit, to allow for easy replacement without the use of tools.

C. The gravity drainage section shall have a minimum dewatering area of 93 square feet.

D. The filter belt, while in the gravity drainage section, shall be supported by a steel grid fitted with high-density polyethylene wiper bars. The wiper bars shall be spaced at a maximum of two and one half inches and shall have a nominal wear thickness of one half inch, to minimize the frequency of replacement. The wiper bars shall be arranged in a chevron pattern, with the apex toward the sludge inlet, to reduce the possibility of belt creasing. The belt support grid shall be a minimum of 2 inches wider than the belt on each side and so designed to reduce belt wear. Wiper bars constructed of fiberglass, other high friction materials, or table rollers, which require extra maintenance due to coatings, and additional bearings shall not be considered an acceptable substitute to this specification.

E. The gravity drainage section shall be furnished with chicanes (plows) to adequately furrow the conditioned sludge to facilitate drainage. Each row of chicanes shall be provided with a single lifting handle, designed to remove the entire row of chicanes at least 6 inches from the belt, out of the sludge flow, to facilitate cleaning. Chicanes shall be designed to be individually adjustable laterally and shall pivot to allow them to pass over obstructions on the belt. The minimum of number of chicanes shall be 84, and the minimum number of rows shall be 10.

F. The manufacturer shall be required to demonstrate that each individual chicane shall be capable of allowing a one-inch vertical obstruction on the belt to pass under them without damage to the equipment.

G. Vacuum assisted, inclined gravity drainage sections, which are subject to flooding, or independent gravity drainage sections, which require a separate belt drive motor and tensioning device will not be considered an acceptable substitute to this specification.

2.05 PRESSURE SECTION

A. Each belt filter press shall be furnished with a pressure section following the gravity drainage section. The pressure section shall consist of two stages.

B. The first stage of the pressure section shall be the increasing pressure (wedge) zone, where the upper and lower belts gradually converge, creating a belt/sludge sandwich. In the wedge zone the sludge cake is prepared for the shear pressure zone by generating continuously increasing pressure on the sludge as it travels through the zone.

C. For process flexibility, the amount of pressure exerted on the sludge and the rate at which the increasing pressure is applied shall be independently adjustable while the machine is in operation utilizing an adjustable steel wedge plate located between the belts, pressing down on the sludge. These adjustments shall be capable of being performed without causing undue wear on the belts or other components and without causing the belts to be moved from their normal path between rollers. The sludge inlet height at the entrance to the wedge plate shall be adjustable between one and three inches.

D. The minimum effective dewatering area in the increasing pressure zone shall be 59 square feet. The belt in the increasing pressure zone shall be supported in the same manner as supported in the gravity drainage section

E. The second stage of the pressure section shall be the shear pressure zone consisting of a 12" radius curved grid and a minimum of eight pressure rollers arranged to provide a serpentine pattern of belt travel.

F. The curved grid shall further enhance dewatering by causing the pressure on the sludge between the belts to increase and press out free water. The horizontal wiper bars shall give a wiping action to the bottom of the belt in the wedge zone that will quickly remove water from the belt allowing faster drainage. The belt-supporting grid in the wedge zone shall be horizontal for the first several feet and blend into a gradual downward curve, which shall be tangent to the perforated pressure roller that follows.

G. The first roller in the increasing pressure zone shall be a 16" perforated roller. Rollers shall be constructed as specified under "Rollers". The rollers shall be supported by bearings mounted on the end shafts as specified under "Bearings".

H. The minimum effective dewatering area in the shear pressure zone shall be 121 square feet. The effective dewatering area in the shear pressure zone shall be defined as the area of curved grid and rollers in contact with the belts, meaning full width of the belt.

2.06 ROLLERS

A. All Solid Rollers shall be constructed using one-piece forge shafts and end plates. The forged stub shaft unit shall eliminate all welding of the roller shafts in the region

of highest stress where the shafts join with the end plates. Welded up constructions of round bar and flat plates that create built in stresses and stress concentrations will not be considered equal to this specification. If stub shaft and end plate construction is used, then the manufacturer must provide one spare roller of each size on the press with delivery of the press. The forged stub shaft unit shall be welded to the roller shell with a machine-applied weld using the submerged arc process. The weld depth shall be equal to the wall thickness of the roller shell. The roller shall be machined so that the total indicated runout of the shell relative to the journals is 0.010 inch maximum. Total surface machining is required to provide a smooth surface for the coating of thermoplastic nylon or to prepare the roller for cladding. The finished shaft size shall be a minimum of 2.95" through the bearing.

B. The perforated rollers, which are the first two rollers in the pressure section, are designed to allow water to escape out both ends. It shall be constructed with a solid through shaft and at least five (5) radial vanes to support the perforated shell.

C. All roller assemblies shall be designed to have a minimum yield stress safety factor of 6 and a maximum deflection of 0.05 inches when under maximum load. Maximum load shall be based on the summation of forces applied to the roller from roller mass forces and belt tension forces. Tension forces shall include a belt tension of 50 pli and driving torque.

D. Certified calculations, showing that the maximum roller deflection is in compliance with these specifications shall be submitted as set forth in the contract documents.

E. Rollers materials and coatings shall be as specified herein. Other types of protective coatings shall not be acceptable. Rollers shall be coated up to the point of insertion into the bearing block. The use of rollers constructed entirely of Type 316L stainless steel, in lieu of rollers of carbon steel with protective coatings, shall be considered acceptable under this specification; however, the Buna-N rubber coating on the drive rollers shall still be required.

F. The ends of the shafts of each roller shall be equipped with support bearings as specified under "Bearings".

2.07 BEARIINGS

A. All rollers shall be supported by greaseable type, high capacity design roller element bearings, in sealed, splash proof, horizontal split case pillow block housings. The bearings shall be direct mounted on the shaft with a shrink fit backed by a retaining snap ring.

B. Bearings supporting the steering rollers shall be non-self aligning cylindrical roller bearings in pivot mounted pillow block housings.

C. All other rollers shall be supported by self-aligning Type "E" spherical roller bearings with metallic cages, (plastic cages in spherical roller bearings are not acceptable) mounted in fixed pillow block housings.

D. Bearings supporting all the rollers except the steering rollers shall be 75mm bore double row spherical bearings (type E construction) AFBMA size number 22215 with a dynamic radial capacity of 41,500 lb.. Bearings supporting the steering rollers shall be 75mm bore single row cylindrical roller bearings AFBMA size number 2215 with a dynamic radial capacity of 36,500 lb.

E. Bearing housings shall be cast iron with two mounting bolts and four cap bolts. The outer side of the housing shall be solid, without end caps or filler plugs. The housings shall be designed with an integrally cast water trough which, when shrouded by a shaft mounted water flinger, shall divert water from the bearing seal area. The housings shall be cleaned, iron phosphated, and coated with nylon to a thickness of 8-12 mil.

F. The bearing seal in the pillow block housing shall be of nonmetallic construction with a carrier/flinger, which rotates with the roller shaft. A static sealing arrangement between the carrier/flinger and the shaft shall be a triple rubber seal, constructed in a manner that prevents relative rotation between the seal and the shaft. A dynamic sealing arrangement between the carrier/flinger and the bearing housing shall consist of a primary dynamic contact seal of ozone resistant rubber which shall seal by rotational contact with a machined housing surface. A secondary dynamic seal shall be a labyrinth seal between the carrier/flinger and the bearing housing which utilizes a nonmetallic retaining ring to hold the seal assembly in position within the housing.

G. Bearing lubrication shall be performed through stainless steel grease fittings mounted on each bearing housing. All bearings shall be outboard (externally mounted) and shall be greaseable while the unit is in operation. Lubrication shall not be required more often than once every six months.

H. The manufacturer of the belt filter press shall warrant the complete bearing assembly, as specified herein, for a period of five years from the date of start-up, or acceptance of the equipment, whichever occurs first. The warranty shall include all parts and labor for repairing or replacing any bearing that fails during the warranty period.

2.08 BELT WASH SYSTEM

A. Each belt filter press shall be equipped with individual belt wash stations for both the upper and lower belts. Each station shall consist of a spray pipe, fitted with spray nozzles, contained within a fabricated housing which encapsulates a section of each belt. The housing and nozzle assembly shall be readily removable.

B. Nozzle spacing and spray pattern shall be such that the sprays from adjacent nozzles overlap one another at the belt surface. Individual spray nozzles shall be replaceable.

C. The housing shall be sealed against the belt with rubber seals. The spacing between the upper and lower housing shall be adjustable to insure continuous contact between the seals and belt. The seals shall be replaceable without disassembly of the wash station.

D. Each belt wash station shall be furnished with a drain valve having an external handwheel to which is mounted a stainless steel cleaning brush located inside the spray pipe. One full turn of the handwheel shall cause the brush bristles to enter each spray nozzle, and dislodge any solid particles which have accumulated, open the valve and allow the solids particles to be flushed into the drainage system.

E. Belt wash stations shall be the type manufactured by Appleton Manufacturing, Menasha Corporation, Menasha, Wisconsin, the Heinrich Stamm Company, Worms Am Rhein, Germany, or equal.

F. Each belt wash station shall be positioned such that the washing is performed after the cake has been discharged from the belt. The belt wash station shall extend over the full width of the filter belt by a minimum of two (2) inches. The belt shall be cleaned by the belt wash with no blinding. The belt wash system shall be suitable for use with plant effluent water supplied with a booster pump described below.

G. A washwater pressure requirement of 80 gpm at 85 psig shall be supplied to each press. Each press shall have its own individual washwater pump (one required per belt press) at 80 gpm at 105 TDH, the minimum plant pressure will be approximately 49 psi. The belt press manufacturer shall furnish a separately mounted in-line booster pump rated at sufficient capacity and discharge head to meet the process requirements. All controls and equipment necessary to provide a complete and operating system shall be provided for the pumps by the belt press manufacturer, including the controls from the machine control panel as specified hereinafter.

H. Each belt filter press shall be provided with a 1 1/2 inch female pvc connection for belt wash water.

2.09 BELT ALIGNMENT SYSTEM

A. Each belt shall be provided with an automatic belt alignment system to assure proper alignment of both belts at all times. Belt alignment shall be accomplished using a self-contained system that does not require an external power source, except for electrical power.

B. The belt alignment system shall be provided with sensing devices designed with a counter-weighted arm fitted with a ceramic plate, which rides on the edge of the belts to detect their position. The arm shall operate a pilot valve, which in turn affects the position of a hydraulic actuator connected to a pivoted belt alignment roller. The pivoting action of the belt alignment roller shall cause this roller to skew from its transverse position to guide the belts centrally along their path.

C. The alignment systems shall function as a continuous automatic belt guidance system and shall be an integral part of the press. The alignment system shall operate with smooth and slow motions resulting in a minimum of belt travel from side to side. The use of electrical servos or systems which utilize devices that maintain alignment by a large snap action type alternating movement of the alignment roller shall not be considered acceptable to this specification.

D. Rollers for the belt aligning system shall be constructed as specified under "Rollers". Support bearings for these rollers shall be as specified under "Bearings".

E. Backup limit switches for the belt alignment system shall be provided on the machine with sufficient contacts to de-energize all drives and sound an alarm in case of belt over-travel.

F. A hydraulic unit shall be provided, as specified under "Hydraulic Power Unit".

2.10 BELT TENSIONING SYSTEM

A. Each belt shall be provided with a belt tensioning system. The belt tensioning system shall be hydraulically actuated. The design of the tensioning system shall be such that adjustments in tension shall result in immediate changes in dewatering pressure.

B. The belt tensioning system shall be furnished with a control station located on the press so that shutoff of belt tension is possible. Actual belt tension, shall be maintained automatically despite process changes or belt stretching and not require additional adjustment by the operator to maintain the setpoint.

C. The belt tensioning system shall be designed to accommodate maximum belt stretching during the useful life of the belt.

D. The tensioning system shall have two hydraulic cylinders for each belt, directly connected to a rigid tensioning yoke, to provide absolute parallel tension across the entire width of the belt. The tension force shall be constant over the full range of the cylinder.

E. Manual tensioning systems or pneumatic bellows systems, which do not automatically maintain a pre-set pressure on the sludge despite process changes, are not acceptable. Furthermore, air bladders change diameter and, as a result, change force as they extend.

F. Sensing devices shall be furnished for each belt with sufficient electrical contacts to de-energize all drives and sound an alarm in the event of failure of the belt or the tensioning system.

G. Rollers for the belt tensioning system shall be constructed as specified under "Rollers". The roller shaft bearings shall be as specified under "Bearings".

2.11 HYDRAULIC POWER UNIT

A. Each belt filter press system shall be provided with a dedicated hydraulic power system to provide pressurized oil for the steering and tensioning. The unit shall consist of a one-gallon reservoir; variable-displacement pressure compensated hydraulic oil pump and drive motor, hydraulic oil filter (reusable), pressure gauges, piping, valves and cylinders to make a complete operational system. Systems using reservoirs more than one gallon will not be considered acceptable due to the extra cost and maintenance associated with more oil.

B. The pump, motor, reservoir, oil filter and valves shall be mounted directly to the belt press frame to minimize excess piping runs, fittings and hoses. All hydraulic lines shall be properly sized for the pressure and flow of the unit. Pressurized hydraulic lines shall be 316ss tubing and shall be rigidly supported on the structural frame of the press. Flexible lines to cylinders, low-pressure connections to the reservoir, etc. shall be hose of the material and construction appropriate to the application. The hydraulic reservoir shall be made of high-density polyethylene (HDPE) and shall be translucent to allow visual inspection of the oil level.

C. The pump motor shall be a 1hp and shall not exceed a noise level of 70 dBA. The motor shall be a cast iron TEFC 1,200 rpm, NEMA B design with a "C" face mounting for the hydraulic pump adapter. Systems utilizing more than 1 hp will not be considered equal.

D. Maximum system pressure shall be set equal to the highest pressure required to obtain the desired operating belt tension. The maximum system operating pressure is 1,000 psi.

E. Hydraulic system controls shall be grouped for easy access and ease of operation. There shall be means provided to retract the belt tension cylinders for service. The valves, fittings, manifold and associated parts shall be of non-corroding materials such as FRP, glass filled Nylon and stainless steel.

F. The oil pressure gauge(s), one for each pair of belt tension cylinders (upper & lower belt) shall indicate oil pressure in PSI and the belt tension in PLI. Normal operating limits shall be indicated on the face of each gauge. Low-pressure switch(es) shall be provided to sense the absence of belt tension pressure.

G. Hydraulic cylinders shall have a non-corrosive body and 316 stainless hardware and cylinder rod. The cylinder rod shall be solid stainless with a hardened polished seal contact surface. Chrome or nickel plated rods are not acceptable.

2.12 BELT DRIVE

A. Input power to the drive roller shaft shall be supplied through an A.C., variable frequency drive unit. Speed shall be controlled through cyclical variation in motor

current, which is operator set at the control panel. The drive roller speed reduction is obtained through a helical gear reducer.

B. Drive Motor Data:

Quantity per Machine	1
Maximum Horsepower	3 horsepower
Power Requirements	230/460 v.a.c., 3 phase, 60 cycle.
Rated Speed	1740 r.p.m.
Nema Design	B
Insulation Class	F
Enclosure	TEFC
Service Factor	1.15
Special Features	Severe duty rating

C. Systems requiring more than a 3 hp drive will not be acceptable.

D. The variable input power (VFD driven) shall be transmitted through a helical bevel gear reducer connected to the drive roller. The drive roller shall be constructed as specified under "Rollers" and shall be surfaced with a Buna-N rubber coating to permit slip free transmission of driving torque to the belt.

2.13 DEWATERING BELTS

A. Each belt filter press shall incorporate the use of two dewatering belts. Belts shall be fabricated of monofilament polyester and shall have 316 Stainless Steel seams. The mesh design shall be selected for optimum dewatering of the sludge to be processed and provide for a 2,000-hour belt life when operated in accordance with the manufacturer's instructions.

B. Belt selection shall be based on the manufacturer's experience obtained from testing the sludge during start-up of the belt filter press(es) and at other installations dewatering similar sludges with similar polyelectrolyte conditioning chemicals.

C. Each belt and connecting seam shall be designed for a minimum tensile strength equal to five times the normal maximum dynamic tension to which the belt shall be subjected. The seam shall be designed to fail before the belt.

D. Belts shall be designed for ease of replacement with a minimum of belt filter down time. Belt replacement shall be such that disassembly of the equipment is not required.

2.14 DISCHARGE BLADES

A. Discharge blades shall be provided to scrape dewatered sludge from the belt at the final discharge rollers. The blades shall be of ultra high molecular weight polyethylene (UHMW) construction and shall be readily removable. The blades should be automatically adjusted.

2.15 DISCHARGE PANS

A. Drainage pans shall be provided as necessary to contain filtrate from all dewatering areas within the belt filter press without splashing and to prevent rewetting of downstream cake. All drainage piping shall be furnished, adequately sized for the intended service, and rigidly attached to the press frame. Drainage piping shall terminate inside the structural frame at the bottom of the press. Drain connection shall be self-venting to prevent overflow. Drainage pans shall be located so that the moving belts do not come into contact with the pans under any condition.

2.16 CONTROL SYSTEM

A. Each belt filter press shall be provided with a control panel that will contain the necessary control devices and equipment for controlling the dewatering process as described herein.

B. The control panel shall accept a 460 VAC, 60 hertz, 3-phase power input. A main disconnect circuit breaker and operator mechanism shall be included. When the disconnect is in the open position, all power shall be removed from the control system. NEMA rated motor starters shall be provided for the hydraulic unit and washwater pump. A VFD will be supplied for the belt drive. Short circuit protection for each motor shall be accomplished utilizing thermal magnetic circuit breakers. Individual thermal overload protection shall be provided (except for the belt drive). A control power transformer shall be included that will provide 120 VAC control power to the system. All logic functions for the system shall be performed by an industrial programmable logic controller (PLC) located in the control panel, a Bristol Control Wave Micro that matches all other PLC's provided an this Contract.

C. Provide an online uninterruptible power supply (SOLA S3K or equal) for power to PLC system and selected equipment.

D. Located on the front of the control panel shall be a CONTROL POWER OFF/ON switch. When in the ON position, the CONTROL POWER ON pilot light will be illuminated and control power shall be distributed to the control system. When in the OFF position, the control system shall be held de-energized. Also located on the control panel shall be an EMERGENCY STOP pushbutton. It shall be an illuminated mushroom head style pushbutton that when depressed shall immediately de-energize all moving equipment in the system. An alarm horn shall be included for audible alarm annunciation.

E. System Operation - As a minimum, the following control pilot devices shall be located on the front of the control panel:

HAND/OFF/AUTO MODE selector switch
HAND MODE indicator
AUTO MODE indicator
AUTO START pushbutton

AUTO STOP pushbutton
SYSTEM RESET pushbutton
ALARM SILENCE pushbutton
LAMP TEST pushbutton
PRESS READY indicator
DEWATERING OFF/ON selector switch
WASHDOWN CYCLE ON indicator
WASHWATER PUMP START pushbutton
WASHWATER PUMP STOP pushbutton
WASHWATER PUMP RUNNING indicator
HYDRAULIC PUMP START pushbutton
HYDRAULIC PUMP STOP pushbutton
HYDRAULIC PUMP RUNNING indicator
BELT DRIVE START pushbutton
BELT DRIVE STOP pushbutton
BELT DRIVE RUNNING indicator
CONVEYOR START pushbutton
CONVEYOR STOP pushbutton
CONVEYOR RUNNING indicator
BELT DRIVE SPEED controller (0-100%)
SLUDGE PUMP SELECTOR (Pump 1, 2, 3, or 4)
SLUDGE PUMP START pushbutton
SLUDGE PUMP STOP pushbutton
SLUDGE PUMP RUNNING indicator
SLUDGE PUMP SPEED controller (0-100%)
POLYMER PUMP START pushbutton
POLYMER PUMP STOP pushbutton
POLYMER PUMP SPEED controller (0-100%)
LOW WASHWATER PRESSURE indicator
LOW HYDRAULIC PRESSURE indicator
BELT MISALIGNED indicator
BELT BROKEN indicator
NO CAKE indicator
EMERGENCY STOPPED indicator

F. Refer to schematics provided for additional details

G. The control panel shall require the following discrete signal inputs from others. The signals shall be normally open dry contacts and shall close when the equipment is running.
   1. Sludge pump running (through the SCADA system)
   2. Polymer pump running
   3. Conveyor running

H. The control panel shall provide the following discrete signals for use by others. The signals shall be dry contacts.

1. Press running (N.O. close when running)
2. Press fault (N.O. close on alarm)
3. Conveyor run (N.O close to run)
4. Sludge pump run (through the SCADA system)
5. Polymer pump run (N.O. close to run)

I. The control panel shall require the following analog signals from others.
1. Sludge pump speed or flow, 4-20 mA
2. Polymer pump speed or flow (4-20 mA)

J. The control panel shall display the following analog signals.
1. Sludge pump speed, 4-20 mA (through the SCADA system)
2. Polymer pump speed (4-20 mA)

K. Sequence of Operation - The press may be operated in the automatic mode by placing the HAND/OFF/AUTO selector switch in the AUTO position. The AUTO MODE indicator will illuminate and the operator will press the AUTO START pushbutton. At this time, the hydraulic pump, washwater pump and washwater valve will be energized and a belt tensioning time delay will start.

L. After the belt tensioning timer times out, the belt drive will be energized and a belt pre-wet time delay will start. After the pre-wet timer times out, the conveyor PRESS READY pilot light will be illuminated and, if the DEWATERING ON/OFF selector switch is in the ON position, the sludge and polymer pumps will be energized.

M. Pressing the AUTO STOP pushbutton will de-energize the sludge and polymer pumps, illuminate the WASHDOWN ON pilot light and start a wash down time delay. After the wash down timer times out, the belt drive, washwater valve, washwater pump, hydraulic pump and conveyor will be de-energized.

N. To operate the press in the manual mode, the operator will place the HAND/OFF/AUTO selector switch in the HAND position. The HAND MODE indicator will be illuminated. The operator will start the washwater pump by pressing the WASHWATER PUMP START pushbutton; start the hydraulic pump by pressing the HYDRAULIC PUMP START pushbutton. Anytime the washwater pump is running, the washwater valve shall be energized.

O. The operator should not proceed until the belts have been fully tensioned. No interlock is provided to prevent the operator from starting the belt drive in the manual mode. Pressing the BELT DRIVE START pushbutton will energize the belt drive and after a pre-wet time delay will illuminate the PRESS READY pilot light. At this time, the operator will start the conveyor by pressing the CONVEYOR START pushbutton, start the sludge pump by pressing the SLUDGE PUMP START pushbutton and start the polymer pump by pressing the POLYMER PUMP START pushbutton.

P. Pressing the respective STOP pushbutton in the reverse order stated above will stop the system

Q. Faults - When any of the following fault conditions occur, in automatic or manual mode, the appropriate fault indicator will be illuminated, the alarm horn will sound and the belt filter press and associated equipment will be de-energized.

EMERGENCY STOP
LOW WASHWATER PRESSURE
HYDRAULIC PRESSURE FAULT
BELT MISALIGNED
BELT BROKEN

R. The following fault conditions will cause the wash down cycle to be initiated in the automatic mode (annunciation only in the manual mode): NO CAKE

S. Enclosure - Control panel enclosures shall be fabricated of type 304 stainless steel and shall be suitable for NEMA 4X service. Enclosures shall be manufactured by Hoffman Manufacturing, Hammond Manufacturing, or equal

T. Wiring - All power and control wiring shall be 600 volt, type THHN/THWN insulation stranded copper and shall be sized for the required load, 14 AWG minimum.

U. Circuit Breakers - The circuit breaker for the main disconnect shall be thermal magnetic molded case units. The circuit breaker shall be Square D, Class 650, Type FAL, or equal

V. Motor Starters - Motor starters shall be full voltage, nonreversing, NEMA style across-the-line units. Coils shall be 120 VAC

W. Selector Switches - All selector switches shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Selector switches shall be Square D, Type SK or equal

X. Push Buttons - All pushbuttons shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Contact blocks shall be rated for 10-ampere continuous service. Pushbuttons shall be Square D, Type SK or equal.

Y. Pilot Lights - Pilot lights shall be heavy duty, oil tight/watertight, corrosion resistant units rated for NEMA 4X service. Units shall be 120 VAC transformer type. Pilot lights shall be Square D, Type SK or equal

Z. Terminal Blocks - Terminal blocks shall be high density, solderless box lug style, with 600 volt rating. Terminal blocks shall be Square D, Class 9080, Type M, or equal.

AA. Programmable Logic Controller (PLC) - The PLC shall be a modular type with discrete and analog capabilities. Control Wave Micro as specified in Division 13.

BB. Variable Frequency Drive (VFD) - The VFD shall be UL listed and shall be IDM Controls Model PoWrMaster or approved equal

2.17 SPARE PARTS

A. The following spare parts shall be furnished with the belt filter presses:
   1. One set of filter belts for each press supplied.
   2. Two complete sets of doctor blades for each press supplied.
   3. One of each size and type of roller bearing complete.
   4. Two complete sets of rubber seals for the gravity and wedge zone for each press supplied.
   5. Two complete sets of belt wash box seals for each press supplied

PART 3 EXECUTION

3.01 INSPECTION

A. Refer to manufacturer's instruction and installation manual before proceeding with installation of equipment.

B. Examine equipment and components for damage or loss. Inform Engineer of damage, loss, or defects. Do not proceed with installation until damage, loss or defects have been corrected.

3.02 INSTALLATION

A. Install each press in accordance with manufacturer's literature.

B. Set units level and true, shim to proper elevation and grout in place using nonshrink, nonmetallic grout. Do not grout units in place until installation has been inspected by a manufacturer's representative.

3.03 PAINTING

A. Field paint each pump, motor and base plate in accordance with Section 09900.

3.04 START-UP AND TESTING

A. See Section 01650 for general testing requirements.

B. Correct all deficiencies to satisfaction of Engineer.

3.05 FIELD QUALITY CONTROL

A. Manufacturers Field Services:
   1. Provide a factory-trained engineer for equipment installation, start-up and training in accordance with the provisions of Section 11005.

END OF SECTION

SECTION 11600

LABORATORY EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Temperature controlled laboratory equipment for Operator's Laboratory.

B. Related Sections:
1. Submittals: Section 01300.
2. Products: Section 01600.
3. Basic Equipment Materials and Methods: Section 11005.
4. Division 15 - Plumbing Work.
5. Division 16 - Electrical Work.

1.02 REFERENCES

A. National Fire Protection Association:
1. NFPA No. 30 Flammable and Combustible Liquids.

B. Occupational Safety and Health Act (OSHA) Specifications 1910.23.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
1. Provide temperature controlled laboratory equipment as identified on the Drawings. Catalog numbers refer to first named manufacturer for each component.

1.04 SUBMITTALS

A. Submit Shop Drawings for temperature controlled laboratory equipment in accordance with Section 01300 and Section 11005, demonstrating compliance with these Specifications.

1.05 QUALITY ASSURANCE

A. General Requirements: Comply with provisions of Section 11005.

B. Basis of Design: Drawings are based on VWR Scientific Laboratory Equipment. Bear any costs resulting from changes required for other approved equipment. Submit drawings for approval, showing changes to equipment, piping, structure, electrical work, plumbing work, etc. required for other manufacturers products.

C. Responsibility: To ensure laboratory equipment is properly coordinated and will function in accordance with intent of Specifications, obtain specified material from a

single supplier responsible for proper function of all equipment, as an integrated and coordinated system. Intent of this paragraph is to establish unit responsibility for all equipment with laboratory equipment supplier. Use of word "responsibility" relating to laboratory equipment supplier does not relieve responsibility for equipment coordination, installation, operation, and guarantee.

1.06 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection
   1. Store equipment in accordance with manufacturers instructions.
   2. See Section 01600 for general handling, storage and protection requirements.

1.07 PROJECT CONDITIONS

A. Electrical: Perform electrical connections to equipment and receptacles as work of Division 16.

B. Plumbing: Perform connections to drains, distilled water, cold and hot water, as work of Division 15.

C. Coordination: Coordinate work of this Section with work required under other sections of this Contract to assure a complete and satisfactory installation.

PART 2 PRODUCTS

2.01 COMPONENTS

A. Steam Scrubber Undercounter Washer/Dryers: Provide undercounter steam scrubber washer/dryer as indicated on Drawings.
   1. Washer/dryer to include 6 operating cycles, and 27 wash/rinse/dry options.
   2. Provide washer/dryer with plumbing connections for regular and distilled rinse water.
   3. Unit constructed of stainless steel with fiberglass insulating adhesive acoustical coating and includes status indications, overflow safety switch, and dual thermostats.
   4. Provide unit with top and bottom racks and two 66074-201 flask baskets.
   5. Washer/dryer to operate on 115 volts, single phase, 60 hertz power.
   6. Manufacturers:
      a. Labconco.

B. Refrigerator/Freezers: Provide manual defrosting refrigerator/freezers suitable for laboratory use and U.L. Listed.
   1. Unit to operate on 115V, 60 Hz., 7.2A. power.
   2. Exterior to be acrylic and interior to be one piece corrosion proof ABS plastic with no recesses to trap spilled material.
   3. Refrigerator compartment to obtain operating temperatures between 36 degrees to 50 degrees F. within 10 minutes.
   4. Freezer compartment to have a temperature range of -4 degrees to 10 degrees F.

5. Manufacturers:
   a. REVCO.

C. Chromatography Refrigerators (with glass doors): Provide manual defrosting refrigerator suitable for laboratory use, and U.L.
   1. Unit to operate on 115 volts, 60 Hz., 10A power.
   2. Provide unit with acrylic exterior.
   3. Refrigerator compartment to obtain operating temperatures between 33 degrees to 45 degrees F. within 10 minutes.
   4. Manufacturers:
      a. VWR.

D. Steam Pressure Sterilizer:
   1. Unit to operate on 208/240 volts 60Hz.power.
   2. Operating temperature to 250 degrees F.
   3. Timed sterilization to 0-60 minutes.
   4. Manufacturer:
      a. Market Forge

PART 3 EXECUTION

3.01 INSTALLATION

A. Install temperature controlled laboratory equipment in conformance with provisions of Section 11005 and as indicated on Drawings.

3.02 PAINTING

A. Temperature controlled laboratory equipment to be painted per manufacturer specifications. Touch-up scratches as directed by Engineer.

3.03 PROTECTION

A. Provide reasonable protective measures to prevent temperature controlled laboratory equipment from being exposed to other construction activity.

B. Provide procedures and precautions for protection of materials and installed laboratory equipment from damage by construction activity.

END OF SECTION

SECTION 12359

LABORATORY CASEWORK

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Laboratory furniture including base and wall cabinets, table tops and working surfaces, closures, shelves, laboratory and electrical fixtures, sinks, hardware, trim, components and accessories as indicated on Drawings and as specified herein.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Products: Section 01600.
   3. Basic Equipment Materials and Methods: Section 11005.
   4. Division 15 - Mechanical.
   5. Division 16 - Electrical.

1.02 REFERENCES

A. American Society of Testing and Materials:
   1. ASTM A366, Standard Specification for Steel, Sheet, Carbon, Cold-Rolled, Commercial Quality.
   2. ASTM D570, Standard Test Method for Water Absorption of Plastics.
   3. ASTM D651, Standard Test Method for Tensile Strength of Molded Electrical Insulating Materials.
   4. ASTM D 695, Standard Test Method for Compressive Properties of Rigid Plastics.
   5. ASTM D785, Standard Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials.
   6. ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
   7. ASTM D792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
   8. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.

B. National Fire Protection Association:
   1. NFPA No. 30 Flammable and Combustible Liquids.

C. Occupational Safety and Health Act (OSHA) Specifications 1910.23.

D. Scientific Apparatus Makers Association (SAMA).
   1. SAMA Standard LF-8.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
   1. Furnish and install laboratory furniture as indicated on Drawings and as specified herein. Laboratory furniture includes, but is not limited to metal base and wall cabinets, service shelves, angular brackets, backsplashes, epoxy resin tops and panels, fillers, base cove molding, sinks, plumbing and electrical fixtures, and miscellaneous items needed to provide a complete and operational installation. Arrange laboratory furniture as indicated on Drawings. Any change in arrangement to be approved by Engineer before installation.
   2. Color: Selected by Owner from manufacturer's standards during Shop Drawings review.

B. Performance Requirements: Metal laboratory furniture to conform to method of testing and resulting performance requirements set forth in SAMA Standard LF-8.

1.04 SUBMITTALS

A. Shop Drawings: Submit Shop Drawings in accordance with Section 01330, demonstrating compliance with specifications.
   1. Submit Shop Drawings for laboratory furniture and appurtenances showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fixtures.
   2. Show details and locations of anchorages and fitting to floors, walls and bases.
   3. Include layout of units with relation to surrounding walls, doors, windows, and other building components.
   4. Indicate field conditions to fully demonstrate provisions for work of other trades and relation of furniture to adjoining, supporting, and supported construction.

B. Samples: If requested, submit following samples. Samples to be returned to Contractor after laboratory furniture arrives at site, is inspected by Engineer, and determined to be equal to samples.
   1. One full-sized combination drawer and cupboard unit showing complete construction details. Unit to be incorporated into Work after return.
   2. Sample of all top materials shown or called for and of sufficient size to perform finish requirement tests.
   3. One each of all mechanical service fixtures, locks, door pulls, hinges, and interior hardware.
   4. Above samples, not being incorporated into Work, to be retained by Engineer to ensure that material delivered to jobsite conforms in every respect to samples submitted.

1.05 QUALITY ASSURANCE

A. General Requirements: Comply with provisions of Section 11005.

B. Basis of Design: Drawings are based on Kewaunee Scientific laboratory furniture. Bear any costs resulting from changes required for other approved furniture. Submit

drawings for approval, showing changes to equipment, piping, structure, electrical work, plumbing work, etc. required for other manufacturers products.

C. Responsibility: To ensure laboratory furniture is properly coordinated and will function in accordance with intent of Specifications, obtain specified material from a single supplier responsible for proper function of all furniture, as an integrated and coordinated system. Intent of this paragraph is to establish unit responsibility for all equipment with laboratory furniture supplier. Use of word "responsibility" relating to laboratory furniture supplier does not relieve Contractor from responsibility for equipment coordination, installation, operation, and guarantee.

1.06 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection
   1. Store equipment in accordance with manufacturers instructions.

B. See Section 01660 for general handling, storage and protection requirements.

1.07 PROJECT CONDITIONS

A. Electrical: Perform electrical connections to equipment and receptacles as work of Division 16.

B. Plumbing: Perform connections to faucets, sink traps, and other fixtures as work of Division 15 Mechanical.

C. Coordination: Coordinate work of this Section with work required under other sections of this Contract to assure a complete and satisfactory installation.

1.08 MAINTENANCE

A. Extra Material
   1. Touch-Up Paint: Furnish one 12 oz. can of each type and color for cabinetry used on Project.
   2. Fixtures:
      a. Furnish one dozen valve seats of each type and size valve furnished under this Section.
      b. Furnish one each color of index handles supplied and one each of insert buttons, labeled as necessary.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Suppliers
   1. Kewaunee Scientific Corporation.
   2. VWR Scientific.
   3. Fisher Hamilton.

4. Mott Manufacturing.

2.02 MATERIALS

A. Sheet Steel: Cold rolled, prime grade roller leveled sheet steel meeting requirements of ASTM A366 and treated at mill to be free of scale, ragged edges, deep scratches, or other injurious defects. All gauges to be U.S. Standard 18 gauge, generally except as otherwise specified. Eighteen gauge metal to be used in case construction except as follows:
   1. 20 gauge: Drawer assemblies, door assemblies, adjustable shelves.
   2. 16 gauge: Top horizontal front and rear rails, table aprons, table leg 2- 1/2 inches square.
   3. 14 gauge: Drawer channels, case channels, hinge reinforcements, table leg gussets.
   4. 12 gauge: Corner gussets for leveling bolts, apron corner braces.

B. Glass: Glass for framed sliding and swinging doors to be 1/8 inch float glass. Glass for unframed sliding doors to be 1/4 inch float glass. Glass used in fume hoods or other hazardous locations to be 7/32 inch laminated safety float glass, except glass shielding fluorescent lights in fume hoods to be tempered glass to provide greater resistance to heat and impact.

C. Epoxy Resin: Epoxy resin to be casting type with curing resins specifically chosen for upgrading along with inert fillers from a material that is thermosetting. Epoxy resin to be solid, homogeneous, oven cured, and conform to following physical properties:

Property	Min. Value	Standard
Tensile Strength	8,000 psi	ASTM D651
Compressive Strength	28,000-30,000 psi	ASTM D695
Flexural Strength	17,000-18,000 psi	ASTM D790
Hardness	Rockwell M107-110	ASTM D785
Density	1.92 g/cc	ASTM D792
Water Absorption	0.02% (24 hrs.)	ASTM D570
Heat Distortion Temp	350° F	
Thermal Expansion Coefficient	2.02 x 10^{-5} in/in/°F	

D. Laminated Particle Board: Laminated particle board to have a 1/16" laboratory grade melamine plastic sheet laminated under heat and pressure and attached with moisture resistant adhesive to a phenolic flakeboard core. A plastic moisture barrier is to be applied to prevent premature warping.

2.03 COMPONENTS

A. Cabinet Construction: Metal laboratory cabinets and cases to meet following requirements.
   1. Removable backs to be provided to facilitate access to plumbing and electrical lines.
   2. Cabinets to be constructed to permit quick and easy change (both before and after installation) from drawers to doors, or vice versa, or a substitution of two drawers in place of a standard depth drawer without use of drills or machinery.
   3. Equip units to be located on laboratory floors with leveling devices adjustable from within units.
   4. Doors and drawers to be sound-deadened. Welding of hinges not permitted. Doors to have double panel construction. Drawers to have nylon rollers and safety stops.
   5. Units to be dust-tight with smooth cleanable interiors.
   6. Cupboards to have full depth adjustable shelves. Shelves adjustable in 1/2 inch increments.
   7. Sliding doors to be extruded aluminum suspended from top by adjustable nylon rollers. Glass with sliding doors to be set into extruded rubber channels. Closing of doors to be cushioned by rubber bumpers on doors.
   8. Drawers and doors to have satin finish aluminum pulls with clear lacquer finish.
   9. Drawers and doors to be provided with an embossed lock knockout for installation of locks.
   10. Lazy-susan units to consist of post and upper and lower pivot plates. Upper plate to be fastened to a hat channel piece which is fastened transversely across corner unit. Lower pivot plate to be fastened to unit bottom. Two (2) circular shelves to be supplied. Each shelf to be vertically adjustable with simple tools.
   11. Solvent Storage Cabinets: Design for storage of flammable and combustible liquids. Construction to comply with OSHA and NFPA No. 30 requirements. Factory Mutual Approved and Labeled.
       a. Bottoms, tops, sides and doors fabricated of 18 gauge steel , double panel construction with 1 1/2 inch air space between panels.
       b. Joints welded or screwed to provide rigid enclosure.
       c. Doors to swing on full length piano hinges. Fully insulated.
       d. Right hand door equipped with three point locking device and left hand door provided with full height astragel.
       e. Provide a 2 inch deep liquid tight pan that covers entire bottom of cabinet to contain liquid leaks and spills.
       f. Provide heavy duty shelves with reinforced bottom formation.
       g. Provide cabinet with grounding screw.
       h. Provide cabinet with interior finish same as exterior.
       i. Label cabinet as follows: FLAMMABLE - KEEP FIRE AWAY.
   12. Acid Storage Cabinets: Provide cabinets with construction features equal to other base cabinets.
       a. Cabinets to incorporate a one piece liner insert of linear low density polyethylene sheet. Liner insert to form a one inch deep pan at bottom to retain spillage.

b. Vent each cabinet into fume hood with 1 1/2 inch vent pipe. Provide a positive airflow directly into fume hood exhaust system.

B. Finishes:
1. Exterior surfaces of all metal laboratory units to be given a pre-paint treatment, after welding and before finishing, to provide for adhesion of finish system and to aid in prevention of corrosion.
2. Pre-paint treatment to include cleaning, phosphatizing, and chromic acid stabilization processes.
3. After pre-paint treatment, apply corrosion-resistant synthetic resin shop primer, Sand Tan color, to all treated surfaces.
   a. Include inside of cabinet doors and drawer heads, behind cross rails, inside surfaces underneath cabinet interior bottom panel, inside front and rear posts, inside of subbase members, and behind adjustable shelf front and back edges.
4. Coating cured by baking.
5. Apply high bake, acrylic finish coat to all surfaces. Color or colors to be selected by Owner.

C. Table Tops and Working Surfaces:
1. Epoxy Resin Tops
   a. Epoxy resin tops molded from a modified epoxy resin, compounded and cured to provide optimum physical and chemical resistant properties required of a heavy duty laboratory table top.
   b. Provide tops and curbs of uniform mixture throughout full thickness, and not dependant upon a surface coating that is readily removed by chemical or physical abuse.
   c. Provide non-glaring tops and curbs, black in color.
   d. Provide table tops of 1 inch thickness with drip grooves on underside at exposed edges.
   e. Exposed edges rounded to 1/4 inch radius at front top edge and vertical corners except as indicated elsewhere in this Section.
   f. Provide 3/4 inch thick integrally molded 4 inch high curbs at backs and ends of standard 31 inch and 24 inch wide tops. Juncture between top and curb to be coved to a 3/4 inch radius.
   g. Curbs on special width tops and around special cutouts to be same thickness as tops, bonded to surface of top to form a square joint.
   h. Sink cutouts to be smooth and uniform without saw marks. Top edge to have uniform radius of approximately 1/8 inch.
   i. Bottom edge of sink opening finished smooth.
   j. Corners of sink cutouts radiused not less than 3/4 inch.
   k. Indented Table Tops:
      1) Where indicated, provide tops 1/4 inch thick at outer edge, indented 1/4 inch to provide a raised rim 5/8 inch wide around exposed edges.
      2) Juncture between raised rim and top surface coved to a 1/4 inch radius.
   l. Service ledge to include a curb riser, an 8 7/16 inch ledge and metal support brackets. Service ledge to be designed for use with epoxy resin table top.

m. Physical Properties:
   1) Flexural Strength (ASTM D790): 15,000 psi.
   2) Compressive Strength (ASTM D695): 35,000 psi.
   3) Hardness, Rockwell M (ASTM D785): 100
   4) Water Absorption(ASTM D570):
      a) Percent by Weight, 24 Hours: 0.02
      b) Percent by Weight, 7 Days: 0.04
      c) Percent by Weight, 2 Hour Boil: 0.04
   5) Specific Gravity: 1.97
   6) Tensile Strength: 8,500 psi.

2. Plastic Laminate Tops
   a. Plastic laminate tops and backsplash to be build up to a 1/16 inch thick plastic surface (color and pattern to be selected by Owner). Attach to sub-top with water resistant adhesive.
   b. Substate to be of 40 - 45 lbs medium density particle board to make a finished top surface of 1 inch thickness.
   c. Exposed edges to be self-edged bandro. Self-edges to be applied prior to application of top sheet and overlapped by top sheet.
   d. Particle board edges and underside of top to be sealed.
3. Shelving
   a. Shelves to be risistop with a radiused to front edge and a black satin chemical resistant finish.
   b. Shelf brackets to be made of cold rolled steel and coated with a chemical resistant epoxy.

D. Fume Hoods:
   1. General:
      a. Fume hoods to operate in conjunction with entire laboratory ventilation and air-conditioning systems to ensure that sufficient supply air as well as exhaust air is conveyed to perform physical work of carrying contaminated air away from operations.
      b. Fume hoods to be of size and type indicated. All materials used in fume hood superstructures to be highly fume-and-fire-resistant.
      c. 48 inch fume hood in Wet Chemistry Lab to be complete with remote mounted exhaust and auxiliary air fans as specified in Division 15.
      d. Fume hood in Wet Chemistry Lab to be complete with auxiliary air plenum kit.
      e. Hood construction to be double-wall type. Exterior to be 18-gauge steel finished to match adjacent equipment. Exterior to be smooth and flush, especially designed and constructed for accommodation of interior shell.
      f. Fume hoods to be provided with PVC vent collars in roofs of fume hood chambers for connection to ductwork system.
   2. Construction:
      a. Hoods to be provided with lift-away side panels and removable front panels to access plumbing fixtures, electrical wiring, counterbalance sash weights, and lighting fixtures, where specified on individual hoods. Provide removable type 316 stainless steel facia corner covers mounted vertically on

each side of hood sash opening to access plumbing lines and valve connections from front of hood.

b. Provide an air foil directly across bottom of sash opening to allow air to bypass underneath and sweep across work surface to prevent any backflow of fume from coming out front of hood. Air foil to be at least 5" wide and extend back under sash to prevent closure of bypass opening when sash is in completely closed position.

c. Hood exterior to feature a dry epoxy powder paint applied electrostatically. Exterior rear panel to be of galvanized steel.

d. The interior liner and baffle to be fabricated of PVC resistant to acids. The liner to be one piece molded construction with coved corners. The temper resistant baffle to be one piece molded without surface slots or adjustable capability. The baffle to provide equal draw, for both heavier and lighter than air vapors and fumes throughout hoods. Baffles to be removable for cleaning. Both liner and baffle to have a flame spread of 25 or less in accordance with ASTM E84 testing.

e. Hoods to be equipped with a single vertical rising 3/16" tempered safety glass sash, counterbalanced by a single weight suspended by two vinyl coated stainless steel cables passing through ball bearing nylon pulleys. Sash or sashes to operate smoothly without tilting when raised or lowered from either end and to remain at rest in any open position. Sash tracks to be of Type 316 stainless steel. All sashes framed with extruded polyvinyl chloride (PVC).

f. Hoods to be provided with one service fixture capable of providing cold water. Service to be provided through forged brass remote controlled valves featuring stainless steel Vee tip construction and epoxy-coated brass 10-serration hose connectors. Fixtures located inside fume hood cavity. Hose connectors to be rear oriented to prevent accidents but still be readily accessible without exposing operator's breathing zone to interior. Services to be completely preplumbed using copper tubing. Service fixture feed lines to be designed to drop below hood work surface and into base cabinet plumbing lines. Fixture handles to be antisnag, round plastic without projections, color coded and labeled for designated type of service.

g. Standard hoods to be provided with a two tube fluorescent lighting system (bulbs included) located behind a polycarbonate safety shield. Fluorescent light assembly to be serviceable from outside fume hood cavity. Hoods to be provided with light switch, blower switch, and all internal wiring to central junction boxes.

h. Hood work surface to be of solid 1-1/4" thick epoxy resin (black) and have a 3/8" deep dished surface conforming to hood interior. Provide cutout relief holes for passage of service fixture lines. Provide vent hole located in rear edge of work surface for connection to and provision for venting of acid storage cabinet.

i. Explosion proof hoods to be provided with two 100 watt explosion proof incandescent lights. Explosion proof hoods to be provided with explosion proof exhaust and auxiliary air fans as specified in Division 15. Explosion proof hoods to be provided with explosion proof wiring.

2.04 ACCESSORIES

A. Sinks and Drain Troughs:
   1. Molded epoxy resin sinks compounded with selected materials to provide maximum physical and chemical properties, black in color with inside corners coved and bottom pitched to drain outlet. Sink to possess a high resistance to mechanical and thermal shock meeting following mechanical and physical strength requirements:
      a. Tensile Strength: 9,500 psi.
      b. Compressive Strength (ASTM D695): 35,000 psi.
      c. Flexural Strength (ASTM D790): 19,000 psi.
      d. Hardness, Rockwell M (ASTM D785): 115.
      e. Specific Gravity: 1.93
         1) Water Absorption (ASTM D570): 0.04
         2) Percent by weight, 24 hours: 0.02
         3) Percent by weight, 7 days: 0.04
         4) Percent by weight, 2 hour boil: 0.04

B. Mechanical Service Fittings:
   1. Laboratory Service Fittings: Laboratory grade service fittings, water faucets, and valve bodies of cast red brass alloy or bronze forgings. All fittings to be chromium plated unless otherwise specified.
   2. Water Fittings: Provide water fittings with a renewable unit containing all operating parts subject to wear. Provide unit with integral volume control device. Provide faucets capable of converting from compression to self-closing, without disturbing faucet body proper. Four (4) arm forged brass handles to contain plastic screw on type colored service index buttons.
   3. Ground Key Valve Hose Cocks: Provide ground key type valves of forged body with 10 serration hose end. Handle plug to be forged brass, long tapered type with screw on colored service index button. Valves to be individually ground, lapped and sealed.
   4. Gooseneck Type Outlets: Provide outlets with separate brazed couplings to provide a full thread attachment of anti-splash, serrated tip or filter pump fittings.
   5. Service Index Buttons: Service index buttons to conform to following color coding:
      a. Hot Water: Red.
      b. Cold Water: Dark Green.
   6. Electrical Fittings: Provide 125 volt 20 amp AC, 3-wire polarized, ground fault interrupter receptacles, unless otherwise specified. Pedestal and line type boxes to be aluminum, metallic finish with stainless steel flush plates. Receptacle boxes constructed of plated steel. Electrical conduit fittings to meet requirements of National Electrical Code.
   7. Sink Outlets: Unless otherwise specified, sink outlets for other than stainless steel sinks to be molded epoxy resin, with integral cross bars, tapered for overflow and complete with gasket and lock nut with 1-1/2 inch IPS male thread outlet. Overflows not furnished for sink outlets unless specifically called for.

8. Service fixtures factory assembled, including assembly of valves and shanks to turrets, flanges and other mounting accessories and each fixture individually factory tested. Fixtures to be tested at following pressures:
   a. Ground Key Cock Valve:
      1) 80 psi air test pressure.
      2) 40 psi maximum working pressure.
9. Sink Traps: Sink traps to be provided for all sinks. Traps to be resistant to all acids, solvents and chemicals normally encountered in a laboratory.
10. Hardware and Trim: Provide hardware and trim necessary for a complete and satisfactory installation as specified by manufacturer.
    a. Sink supports to be hanger type, suspended from top front and top rear horizontal rails of cabinet by a minimum of four 1/4" steel rods. Sink to be sealed to cabinet top to prevent leakage.
    b. Struts to be provided to support hangers, mechanical service piping and drain lines where necessary. Metal to be 16 gauge. Struts to be furnished with hangers to support mechanical service piping.
    c. Leg shoes to be provided on all table legs to conceal leveling devices.
    d. Base molding, filler panels, and scribe strips to be provided to complete installation.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install laboratory furniture in conformance with provisions of this Article, Section 11005 of Specifications and as shown on Drawings. Necessary field modifications to be made in accordance with manufacturers recommendations, after approval of Engineer.

B. Take care to avoid any damage to fixtures, cabinets, counter tops, or service shelves during installation. Protect cabinets with a polyethylene covering. Replace all damaged laboratory equipment at no additional cost to Owner.

C. Install plumb, level, true, and straight with no distortions. Shim as required, using concealed shims. Where metal laboratory furniture abuts other finished work, scribe and apply filler strips for accurate fit with all fasteners concealed where practicable.

D. Adjust base cabinets to within 1/16" of a single plane. Where required, assemble units into (1) integral unit with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16". Provide holes for mechanical and electrical work as shown or as directed by trades involves. Securely fasten wall cabinets to solid supporting materials, not plaster, lath, or wallboard. Anchor, adjust, and align wall cabinets as specified for base cabinets. Reinforcement of stud walls to support wall-mounted cabinets to be performed during wall erection, by trade involved, working from laboratory furniture shop drawings. Responsibility for accurate location and sizing of reinforcement is part of this Section.

E. Adjust laboratory equipment and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

F. Securely attach access panels but provide for easy removal and accurate realignment. Clean surfaces, including both sides of all glazing.

G. Coordinate installation of faucets, traps, gas fixtures, and electrical fixtures with Division 15 and Division 16, respectively.

3.02 PAINTING

A. Shop paint laboratory furniture in conformance with this Section. Touch up scratches as directed by Engineer.

3.03 PROTECTION

A. Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.

B. Contractor to provide procedures and precautions for protection of materials, installed laboratory casework and fixtures from damage by construction activity.

END OF SECTION

SECTION 13100

LIGHTNING PROTECTION

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for exterior building lightning protection system, equipment, and related installations.

B. Related Sections:
   1. Conduit and Tubing: Section 16131.

C. Scope of Work
   1. The Work covered by this Section of the Specifications consists of furnishing all labor, materials and items of service required for the completion of a functional and unobtrusive lightning protection system as approved by the Engineer and in strict accordance with this Section of the Specifications and the applicable Drawings.
   2. If any departure from the Drawings or submittal Drawings covered below are deemed necessary by the Contractor, details of such departures and reasons therefore shall be submitted as soon as practicable to the Engineer for approval. No such departures shall be made without the prior written approval of the Engineer.

1.02 REFERENCES

A. Lightning Protection Institute (LPI):
   1. LPI-175 Lightning Protection Institute Installation Code

B. National Fire Protection Association (NFPA)
   1. NFPA 70 - National Electrical Code (NEC).
   2. NFPA 780 - Lightning Protection Systems

C. Underwriters Laboratories (UL):
   1. UL 96 - Lightning Protection Components.
   2. UL 96A - Installation Requirements for Lightning Protection Systems.

1.03 QUALITY ASSURANCE

A. The lightning protection system shall conform to the requirements of the Lightning Protection Institute and Underwriter's Laboratories Standards for lightning protection systems. An Underwriters' Laboratories Master Label shall be furnished, along with LPI System Certification, including Forms LPI-175A and 175B.

B. The system to be furnished under this Specification shall be the standard product of a manufacturer regularly engaged in the production of lightning protection systems and shall be the manufacturer's latest approved design. The equipment manufacturer shall also be a UL listed and approved manufacturer and a fully certified manufacturer member in good standing of the Lightning Protection Institute.

1.04 SUBMITTALS

A. Pertinent catalog data, as well as complete shop drawings showing the type, size, and locations of all equipment, grounds, and cable routings, etc., shall be submitted to the Engineer for approval prior to start of work.

PART 2 PRODUCTS

2.01 STANDARD

A. All equipment used in this installation shall be UL inspected, approved and properly labeled.

B. All equipment shall be new, the product of a single manufacturer as outlined above, and of a design and construction to suit the application where it is used in accordance with accepted industry standards, UL, LPI and NFPA Code requirements.

2.02 EQUIPMENT

A. The lightning protection equipment shall be manufactured by the following manufacturers:
   1. Thompson Lightning Protection, Inc.
   2. Harger Lightning Protection, Inc.
   3. Heary Brothers Lighting Protection Co., Inc.
   4. Ace Lightning Protection Co., Inc.
   5. Larson Lighting Protection.
   6. Or Approved Equal.

B. All materials shall conform with UL 96 requirements and shall be copper or aluminum as described below, and of the size, weight, and construction to suit the application where used in accordance with LPI and NFPA Code requirements for Class I structures and as per manufacturer recommendations.

C. Conductors shall be UL Listed and consist of 28 strands of 14 gauge aluminum wire weighing 114 lbs (51kg) per 1,000 feet (300m) and installed in accordance with the UL Code. A perimeter cable shall be installed around the entire main roof. Each perimeter cable shall be connected to at least (2) down leads, providing a two way path to ground from each air terminal. All center roof air terminals shall be interconnected with conductors to the outside perimeter cable. Conductors on the flat roof areas may be run exposed. Ground connections shall be made around the perimeter of each roof

and to the main down conductor at the maximum of 100-feet-0-inches (30m) on centers.

D. Downlead conductors from roof to ground shall be copper with 29 strands of 17 gauge wire minimum.

E. Air terminals shall be ½-inch (13mm) x 18-inch (450mm) solid aluminum and shall extend at least 18 inches (450mm) above the object to be protected. Locate and space according to LPI and NFPA requirements. In general, air terminals should be spaced so as not to exceed 20-feet (6m) apart around the outside perimeter of the roof or the ridge and not over 50 feet (15m) apart through the center of flat roof areas. The air terminals in the center roof area shall be 2-inch (13mm) x 48-inch (1.25m) solid aluminum with a proper brace.

F. Air terminal bases shall be of cast aluminum with bolt pressure cable connections and shall be securely mounted with stainless steel screws or bolts. Crimp type connectors are not acceptable. All air terminal bases for flat roof areas shall be secured with a proper adhesive in accordance with the roofing manufacturer and shall have a minimum surface contact area of 18.5 sq. inches (120 sq. cm).

G. Ground rods shall be a minimum of ¾-inch (19mm) in diameter and 10-feet-0-inches long. Grounding terminals shall be located at the base of the structure. Ground connections shall be made around the perimeter of the structure and in no case shall average over 100-feet (30m) apart. Ground terminals shall be driven to a minimum depth of 10-feet (3m) and more if necessary to reach permanent moisture.

H. Conductor fasteners shall be an approved type of non-corrosive metal, have ample strength to support conductors and shall be spaced not to exceed 3-foot (91cm) centers.

I. Bonding devices, cable splicers and miscellaneous connectors shall be of cast aluminum with bolt pressure connections to cable. Cast or stamped crimp fittings are not acceptable.

J. Equipment on stacks and chimneys shall be protected from corrosion and sized in accordance with LPI and UL requirements.

K. All miscellaneous bolts, nuts and screws shall be stainless steel.

L. An approved bimetal transition fitting shall be used at the roof level to change from aluminum roof conductor to copper downlead cable.

2.03 CONDUIT AND CONDUIT FITTINGS

A. Conduit and conduit fittings enclosing single ground wires, without accompanying circuit conductors:

1. Schedule 40 PVC conduit conforming to NEMA TC-2, with fittings conforming to NEMA TC-3, and conforming to Section 16131

2.04 EXO-THERMIONIC WELDED CONNECTORS

A. Provide molds, thermite packages and other material for exo-thermionic welds, that are full-rated to carry 100 percent of cable rating, which are letter-coded, exo-thermionic welded type. Provide items for connections of cable to ground-rod.

B. Provide molds, thermite packages and other material from a single manufacture throughout the job. Acceptable manufacturers, are as follows:
   1. Cadweld.
   2. Thermoweld.
   3. Or Approved Equal.

2.05 COATING/COVERING FOR GROUNDING CLAMPS AND CONNECTORS

A. Provide black, rubber based compound coating materials, permanently pliable, moldable and unbacked, not less than 1/8-inch (3mm) thick with properties as follows:
   1. Solids/Density: 100 percent; 12 lbs. per gallon. (1.5kg per 1 liter)
   2. Penetration: 90-130 (2.3 – 3.3m) in accordance with ASTM D5.
   3. Water Absorption: 0.10 percent maximum in accordance with ASTM D570.
   4. Dielectric Strength: 500 volts/mil (19,685 volts/mm) in accordance with ASTM D149.
   5. Volume Resistivity: 2,000 megohms-inches in accordance with ASTM D257, and 5,000 megohms-CM in accordance with ASTM D257.

PART 3 EXECUTION

3.01 INSTALLATION

A. The installation shall be accomplished by an experienced installer who is a Certified Master Installer as recognized by UL and the LPI or working under the direct supervision of an LPI manufacturer as listed above or his authorized LPI Certified master Installer representative.

B. All equipment shall be installed in a neat workmanlike manner in the most inconspicuous manner possible. The system shall consist of a complete cable network on the roof involving all air terminals, splicers, and bonds with cable downleads routed concealed either directly in the building construction or in conduit to ground.

C. Downlead cables shall not be brought directly through the roof. Thru-roof connectors with solid rods or conduit through pitch pockets shall be utilized for this purpose.

D. The limitations on areas of usage for aluminum cables and for copper and aluminum materials together as outlined in NFPA 780 and LPI 175 shall be observed.

E. Install all systems in conformance with UL 96A requirements.

F. Check location of ground rods for the following; correct all discrepancies, relocate ground rods, if necessary.
   1. Adequate compaction of soil.
   2. Freedom from stones, organic-material, debris rubble, corrosive material.
   3. Adequate clearance from buildings, other work, and utility lines (2-foot 6-inch (76cm) minimum, unless otherwise indicated).
   4. Adequate distance between rods and other ground systems (6-foot 6-inch (198cm) minimum, unless otherwise indicated).

G. Exothermically weld all ground wires to ground rods. Coat connections and area around connections with coating compound. Assure freedom from pin-holes, holidays in coating.

H. Make all connections to equipment with compression, two-hole lugs. Clean paint, grease and such other insulating materials from contact points for ground lugs, and studs; clean all wires to a bright finish prior to connection.

I. Bond all metallic objects on roof to system as required by NFPA 780.

J. Conceal all down leads in 1 1/2-inch (4cm) Schedule 40 PVC conduit.

K. Seal all conduit openings with duct seal.

3.02 COORDINATION

A. The lightning protection installer shall coordinate with other trades to insure a correct, neat and unobtrusive installation.

B. It shall be the responsibility of the lightning protection installer to assure a sound bond to the main water service and to assure interconnection with other building ground systems, including both telephone and electrical.

3.03 COMPLETION

A. The lightning protection installer shall secure and deliver the LPI System Certification to the Engineer for the Owner upon completion of the installation.

B. The Contractor shall also submit copies of as-built shop Drawings with LPI Forms 1-R-91 along with the LPI Certified System Application.

C. Underwriters' Laboratories, Inc. Master Label shall be furnished as evidence that the installation has met with UL 96A code requirements.

END OF SECTION

SECTION 13210

CHEMICAL TANKS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision for cross linked high density polyethylene and steel tanks and accessories. All tanks and accessories to be furnished as part of Phase 1 construction.

B. Related Sections:
1. Submittals: Section 01300.
2. Testing: Section 01600.
3. Paints and Coatings: Section 09900.
4. Basic Equipment Materials and Methods: Section 11005.

1.02 REFERENCES

A. American Society for Testing and Materials:
1. ASTM C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
2. ASTM D638, Standard Test Method for Tensile Properties of Plastics.
3. ASTM D746, Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
4. ASTM D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
5. ASTM D1056, Standard Specifications for Flexible Cellular Materials.
6. ASTM D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D1525, Standard Test Method for Vicat Softening Temperature of Plastics.
8. ASTM D1998, Standard Specification for Polyethylene Upright Storage Tanks.
9. ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
10. ASTM E96, Standard Test Methods for Water Vapor Transmission of Materials.

B. Steel Structures Painting Council:
1. SSPC-SP-6 Commercial Blast Cleaning.

1.03 SYSTEM DESCRIPTION

A. Design Requirements:
1. Provide tanks of material type, quantity, size and design indicated in following schedule.

Chemical Stored	Chemical Strength	Number Tanks	Max. Tank Diameter (in.)	Max. Tank Side Shell Height (in.)	Min. Tank Capacity (gal.)	Material (FRP) (XLPE) (STEEL)
Bulk Storage Tanks						
Polyaluminum Chloride	3.30 lb/gal	2	144	204	12,000	XLPE
Ferric Chloride	4.40 lb/gal	2	144	204	12,000	XLPE
Corrosion Inhibitor	13.20 lb/gal	1	94	192	5,000	XLPE
Caustic Soda	50%	2	94	192	5,000	XLPE
Hydrofluosilicic Acid	1.77 lb/gal	1	102	196	6,000	XLPE
Sodium Thiosulfate	3.20 lb/gal	1	94	192	5,000	XLPE
Polymer (Sludge Press)	8.34 lb/gal	1	122	145	6,350	XLPE
Ammonia Hydroxide	1.47 lb/gal	1	120	168	8,000	Steel
Day Tanks						
Polyaluminum Chloride	3.30 lb/gal	2	73	152	2,100	XLPE
Ferric Chloride	4.40 lb/gal	1	61	141	1,500	XLPE
Corrosion Inhibitor	13.20 lb/gal	1	31	57	150	XLPE
Caustic Soda	50%	1	64	98	1,000	XLPE
Hydrofluosilicic Acid	1.77 lb/gal	1	31	57	150	XLPE
Sodium Thiosulfate	3.20 lb/gal	1	23	42	50	XLPE
Potassium Permanganate	0.20 lb/gal	1	64	120	1,400	XLPE
Polymer (Sludge Press)	8.34 lb/gal	1	28	42	100	XLPE
Ammonia Hydroxide	1.47 lb/gal	1	31	57	150	Steel

2. The following design requirements apply to all tanks:
   a. Chemicals will have maximum entry temperatures of approximately 140 degrees F.
   b. Bulk storage tanks to be vertical with integral flat bottoms, Integrally Molded Flanged Outlet (IMFO) and domed tops.
   c. Polymer Tank to be provided with sloped bottom.
   d. Overall tank height not to interfere with support beams of second floor.
   e. Provide day and batch tanks with integral flat bottoms.
   f. Where shown on Drawings, provide batch tanks with dished bottoms and skirts.
   g. Chemicals will have maximum temperatures of approximately 200 degrees F.
   h. Provide bulk storage tank with 1 inch of insulation.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings in accordance with Section 01300 and Section 11005, demonstrating compliance with Specifications.

B. Certificates:
   1. Submit manufacturer's certification that each tank will withstand continuous duty with its intended chemical without defects.

C. Samples: Submit manufacturer's standard color samples for Owner's selection.

1.05 QUALITY ASSURANCE

A. General Requirements: Comply with provisions of Section 11005.

PART 2 PRODUCTS

2.01 CROSS LINKED HIGH DENSITY POLYETHYLENE TANKS

A. General: Provide cross-linked high-density polyethylene tanks at locations indicated on Drawings. Confirm with manufacturer that tank materials are compatible with chemicals being stored.
   1. Provide tanks meeting requirements of ASTM D1998, ASTM D1505, ASTM D638, ASTM D1525, ASTM D746, and ASTM D790.

B. Tank Construction:
   1. Rotationally molded of high density crosslinked polyethylene, and of vertical, cylindrical, IMFO (Integrally Molded Flange Outlet) bottom, seamless design.
   2. Plastic used in tank construction is to contain a minimum of .25% U.V. stabilizers and maximum of .50%, and contain no fillers. Pigments added as selected by Owner. Furnish color selection charts.
   3. Edges where openings are cut into tanks and covers to be trimmed smooth.
   4. Finished surface to be free from visual defects such as foreign inclusions, air bubbles, pin holes and craters, as commercially practical.
   5. Provide bulk storage tanks with an integral domed cover.
   6. Provide batch and day tanks with snug fitting removable cover with required cutouts, constructed of same material as tank.
   7. Provide batch and day tanks with flanged, gasketed high density polyethylene rigid covers with plastic bolts and cutouts as required.
   8. Provide day tanks with an integral domed cover.

C. Connections:
   1. Bulk Storage Tanks:
      a. Provide bulkhead fittings with 150 psi drilled flanged nozzles on fill, vent, and probe. Suctions to be bolted flanged fittings with IMFO type connections.
      b. Size and location of each connection as indicated on Drawings.

c. Provide for each flanged connection, rubber full-face ring gaskets of either synthetic or natural rubber, which are resistant to stored chemical.
d. Provide bolts of 316 S.S. for each flanged connection.
e. Provide teflon coated hardware on ferric chloride storage tanks.

2. Day Tanks:
   a. Provide threaded bulkhead type fittings on day tank connections.
   b. Provide pump suction and overflow connections. Suctions to be siphon type connections.
   c. Provide IMFO (integrally molded outlets) for allow for full drainage
   d. Provide bulkhead type fittings with flanged nozzles for connection of day tank level probes.
   e. Size and location of each connection is as indicated on the Drawings.
   f. Threaded connections and accompanying gaskets to be constructed and installed to facilitate easy replacement in event of wear or damage.
   g. Provide bulkhead fittings and grommets suitable for withstanding continuous contact with specified strength of chemical at 140 degrees F. without defects.
   h. Provide day tanks with sight level gages and shut-off valves. Materials of construction to be suitable for chemicals within tanks.
   i. Lab waste tank to have integrally molded bottom flanged outlet.
   j. Provide batch mixer connection for permanganate tank.

D. Accessories:
1. Bulk Storage Tanks:
   a. Provide one 24 inch diameter, gasketed, boltdown manway and cover for each bulk storage tank at locations indicated on the Drawings. Manway to be constructed entirely of polyethylene.
   b. Provide a 4 inch flanged connection for vent line, and flanged connections for fill line, level transmitters and probe connections as required. Provide tank inerconnect connector where shown on Drawings.
   c. Provide OSHA approved 22 inch wide FRP ladder with return and Saf-T-Climb rail on each bulk storage tank to access the top manway on the tank for visual inspection.
      1) Mount bottom of ladder on floor and secure to top of tank.
      2) Stop last ladder rung 3 '-6" below top of manway opening.
      3) Saf-T-Climb to be furnished in 316 stainless steel.
      4) Provide all connecting hardware required in 316 stainless steel.
   d. Provide design and anchoring system to meet seismic requirements identified on Drawings.
   e. All hardware on ferric chloride tanks to be teflon coated.
   f. All Fittings should be attached with a flexible expansion joint designed to handle the expansion and contraction of the tank
2. Day Tanks:
   a. Provide removable polyethylene cover with cut outs for fill and vent lines, and pressure relief valve piping. Each cover to be provided with 316 stainless steel hinged polyethylene access hatch for viewing chemicals as indicated on Drawings.
   b. Provide flanged connections for tank level transmitters where required.

c. Provide two complete spare bulkhead fittings and gaskets of each size and type.
d. Provide batch mixer connection for permanganate batch and solution tanks.
e. Provide batch mixer connection for polymer day tank.
f. Provide OSHA approved 22 inch wide FRP ladder with return and Saf-T-Climb rail on each day tank with an AOH greater than 10 feet to access the top manway on the tank for visual inspection.
   1) Mount bottom of ladder on floor and secure to top of tank.
   2) Stop last ladder rung 3 '-6" below top of manway opening.
   3) Saf-T-Climb to be furnished in 316 stainless steel.
g. Ferric chloride tanks require teflon coated hardware.

E. Manufacturer:
   1. PolyProcessing
   2. Snyder

2.02 STEEL TANKS

A. General: Provide steel tanks at locations indicated on Drawings.
   1. Bulk storage tank to be vertical with dished bottom and dished top.
   2. Day tank to be vertical with dished bottom and hinged access hatch.
   3. Bulk tank to be supported on three (3) legs spaced equally around the bottom dished head.
   4. Day tank to be supported on a skirted bottom.

B. Shell:
   1. Bulk Storage Tank fabricated from carbon steel having a minimum thickness of 5/16 inch.
   2. Day tank fabricated from carbon steel having thickness of 1/4 inch.

C. Head: Fabricated from carbon steel having a minimum thickness of 1/4 inch.

D. Joints: Welded on both interior and exterior.

E. Connections:
   1. Bulk Storage Tank:
      a. Provide 150 psi drilled flanged nozzles on fill, vent, probe and suction connections. Suctions to be siphon drain type connections.
      b. Size and location of each connection is as indicated on Drawings.
      c. Provide for each connection, rubber full-face ring gaskets of either synthetic or natural rubber, which are resistant to stored chemical.
      d. Provide bolts of 316 S.S. for each connection.
      e. Provide two 3 inch flanged nozzle connections for immersion type temperature probe.
      f. Provide two half coupling connections for immersion type temperature probe. Install 12 inches above tank bottom.

g. Location of flanged nozzles and half couplings to be coordinated with requirements of heater elements and temperature probes.

2. Day Tank:
   a. Provide half couplings for overflow, fill, vent and pump suction connections. Suction to be of siphon drain type.
   b. Provide flanged connections for use with level probes.
   c. Provide sight level gages for each day tank. Materials of construction to be suitable for chemicals within tanks.

F. Accessories:
1. Bulk Storage Tank:
   a. Provide one 24 inch diameter, 150 psi drilled side manway and cover, and one 24 inch diameter hinged hatch, (standard fuel oil type with skirt to fit over and around opening), at locations indicated on Drawings.
      1) Each manway to be constructed entirely of steel with 316 S.S. bolts.
      2) Provide full face type 3/16 inch thick gaskets of chemical resistant synthetic or natural rubber.
      3) Provide hinged steel hatch mounted on top of tank with loose fitting cover and no latches, hasps or other type locking or fastening devices. Hinged hatch to be free to open and relieve any buildup of pressure in tank during filling operations.
   b. Provide OSHA approved 22 inch wide FRP ladder with Saf-T-Climb rail on each bulk storage tank to access the top manway on the tank for visual inspection.
      1) Mount bottom of ladder on floor and secure to manway at the top.
      2) Stop last ladder rung 3 '-6" below top of manway opening.
      3) Saf-T-Climb to be furnished in 316 stainless steel.
      4) Provide all connecting hardware required in 316 stainless steel.
   c. Provide a set of four steel lifting lugs with each tank. Lugs to be designed to withstand loads associated with lifting tanks vertically or turning a tank from horizontal to vertical position.
   d. Provide design and anchoring system to meet seismic requirements identified on Drawings.
2. Day Tanks:
   a. Provide removable flanged cover with half couplings for fill and vent lines and pressure relief piping.
   b. Provide access hatch with stainless steel hinge for viewing chemical.
   c. Provide flanged connection for level transmitter and probes, where required.

G. Painting:
1. Shop Painting:
   a. Interior: Blast clean to SSPC-SP-6 Commercial Blast Cleaning.
   b. Exterior: Shop prime in accordance with Section 09900.

H. Manufacturers:
1. Highland Tank & Manufacturing Co.
2. Adamson Company, Inc.

PART 3 EXECUTION

3.01 INSTALLATION

A. Bulk Storage Tanks: Install on 6 inch high concrete foundation which provides firm and continuous support over entire bottom area. Due to shrinkage upon curing, irregularities may occur on bottom of tank. Therefore, use grouting in order to provide complete contact between tank bottom and foundation. Grouting consists of a wet grout mixture; 1 to 2 inch thick sheet of two pound density polyurethane foam board; or strips of 15 pound roofing felt. Install grouting in strict accordance with manufacturer's recommendations.
   1. Provide openings in concrete pad for each flush drain connection.
   2. Shim hold down lugs before tightening them whenever there is a space beneath them and concrete pad.

B. Batch/Day Tanks: Install each tank on concrete foundation which provides firm and continuous support along entire bottom.

3.02 START-UP

A. In accordance with Section 01650.

END OF SECTION

SECTION 13222

FILTER MEDIA

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for filter media and underdrain gravel as shown on Drawings and specified herein. Six (6) filter boxes with a total of twelve (12) cells are to be equipped. Five (5) filter boxes are to be equipped as part of Phase 1 construction and one (1) filter box is to be equipped as part of Phase 2 construction.

B. Related Sections:
   1. Products: Section 01600.
   2. Disinfection of Structures and Equipment: Section 01658.

1.02 REFERENCES

A. American Water Works Association:
   1. AWWA B100 - AWWA Standard for Filtering Materials.

B. NSF International:
   1. NSF 61 Listings, Drinking Water Additives - Health Effects.

1.03 SYSTEM DESCRIPTION

A. Design and Performance Requirements:

	Units	Phase 1	Phase 2
Filter Boxes	Number	5	1
Cells per Filter Box	Number	2	2
Filter Cell Width	ft	13	13
Filter Cell Length	ft	27	27
Filter Cell Area	sq ft	351	351
Total Filter Area	sq ft	3,510	702
Nominal Rated Flow	mgd/filter	5.00	5.00
Nominal Rated Filtering Rate	gpm/sq ft	5.00	5.00
Filter Underdrain (Depth)	inches	6	6
Integral Media Support Cap IMS	inches	N/A	N/A
Silica Gravel 1"x5/8"	inches	3	3
Silica Gravel 5/8"x3/8"	inches	3	3
Silica Gravel 3/8"x3/16"	inches	3	3
Silica Gravel 3/16"x0.08"	inches	3	3
Silica Sand	inches	12	12
Anthracite	inches	18	18

1.04 SUBMITTALS

A. Product Data:
   1. Furnish gradation curve for each layer of gravel.
   2. Furnish two (2) grain size distribution curves for silica sand and anthracite.
      a. Obtained from different random samples of material to be supplied.
      b. Determined by an independent soils laboratory, and based on a minimum of 10 sieve sizes between 0.05 mm. size and 2.0 mm. size of particles.
         1) Furnish weight of material retained on each sieve with distribution curves.

B. Samples:
   1. Furnish samples of each layer of gravel, silica sand, and anthracite for approval. Approval based on physical samples, grain size distribution curve, and laboratory report.

C. Quality Assurance/Control Submittals:
   1. Certificates: Submit following notarized certificates:
      a. Certification stating that gravel, silica sand, and anthracite to be shipped has been tested in accordance with AWWA B100 and meets each and all of physical and chemical requirements of those specifications and requirements of this Section. Supply laboratory test data with certifications.
      b. Certification stating that all materials utilized in system are suitable for operation in a potable water application, and bear NSF 61 Certification if in contact with water.
   2. Submit a materials handling plan with a complete description of procedures proposed for handling media on site, within water treatment plant, and during placement operations in filter boxes.

1.05 QUALITY ASSURANCE

A. General Requirements:
   1. Media to be furnished and installed under this Section will perform final polishing process in a potable water treatment plant. Water quality requirements in this plant are very stringent with a goal of 0.1 NTU in filtered water. As such, filter media quality and installation are of primary importance, and conformance with all Paragraphs of these Specifications is mandatory.
   2. Conform to all Sections of AWWA B100 and to supplementary specifications of this Section relative to quality of all material and method of installation. AWWA Specifications govern in event of conflict.
   3. Filter media specified is a complete filtering process. Furnish from one (1) supplier, responsible for satisfactory operation of entire filtering process.

B. Media systems to be standard products of a supplier who has been regularly engaged in successful production of high quality media of this type for at least ten years, has supplied such media for at least five years of ten year period, and has at least five installations in successful operation for at least five years.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection:
   1. Immediately after processing, bag all media for shipment or store, if shipment is to be in bulk form, in a clean and dry location.
   2. Deliver, store and handle filter media in accordance with manufacturer's recommendations, and as supplemented herein:
      a. Store all filter media at project site in a clean area at least 12 inches above ground and removed from other work activities.
      b. Cover material to protect it from dust and other airborne contaminants, and in a manner that will protect media from precipitation.
         1) Replace any material which, in opinion of Engineer, becomes contaminated with dirt or other unsanitary material at no additional cost to Owner.
      c. Protect filter media from freezing.
         1) Replace all media which has been subjected to freezing temperatures at no additional cost to Owner.

B. See Section 01600 for general handling, storage and protection requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Suppliers:
   1. Underdrain gravel and filter media (sand and anthracite) supplied by:
      a. F. B. Leopold Company, Inc., Zelienople, PA.
      b. Unifilt Corporation, Zelienople, PA.
      c. Roberts Water Technologies, Darby, PA

2.02 MATERIALS

A. Underdrain Gravel
   1. General:
      a. Underdrain gravel of hard, rounded stones.
         1) Contain not more than 2 percent by weight of thin, flat, or elongated pieces (pieces in which largest dimension exceeds three times smallest dimension), as determined by handpicking.
         2) Free from shale, mica, clay, sand, loam, and organic impurities of any kind.
      b. Porosity of gravel in any layer:
         1) Maximum: 45 percent
         2) Minimum: 35 percent
      c. Uniformly graded within each layer. Gravel over 1/4 inch in diameter may be screened through wire screens with square openings, or plates with round openings. Use wire screens for sizes smaller than 1/4 inch. Maximum of 8

percent by weight of any layer may be finer or coarser than specified for layer.

2. Silica Gravel:
   a. Specific gravity:
      1) Average: not less than 2.5.
      2) Minimum: less than 1 percent by weight of 2.25 or less.

B. Mixed Media:
   1. Filter Sand
      a. Composed of hard, durable silica grains, either rounded or angular in shape. Not more than 1 percent by weight to be flat or micaceous. Free from dust and organic matter. 95 percent insoluble in a 24-hour bath in warm hydrochloric acid. Specific gravity equal to or greater than 2.6.
      b. Uniformly graded with an effective size not greater than 0.55 mm. nor less than 0.45 mm. The uniformity coefficient shall not be greater than 1.50, and there shall be a uniform distribution of grain size between D10 and D60 size material. The ratio between D20 size and D10 size shall be less than 1.15. Not more than 10% by weight shall be larger than 0.85 mm.
   2. Anthracite
      a. The anthracite shall be obtained from an approved source and must be clean and free from long, thin, or scaly pieces. It shall have a hardness of 3.0 to 3.75 on the MOH scale, and a specific gravity of not less than 1.55. It shall be free from iron sulfide, clay, shale, or extraneous dirt. Its solubility shall be negligible in 40 percent hydrochloric acid and less than 2 percent in hot (190 degrees F.), 1 percent sodium hydroxide.
      b. The coal shall be uniformly graded with an effective size not less than 0.95 mm. nor greater than 1.05 mm. The uniformity coefficient shall not be greater than 1.40, and there shall be a uniform distribution of grain size between the D10 and D60 size material. The ratio between the D20 and D10 sizes shall not be greater than 1.15. Not more than 10 percent by weight of the anthracite shall be larger than 1.85 mm.
   3. Media Depths:
      a. Filter Sand: 12-inches.
      b. Anthracite: 18-inches.

PART 3 EXECUTION

3.01 EXAMINATION

A. Complete all filter box building construction, cleaning, and painting before starting gravel placement.

3.02 INSTALLATION

A. Replace any media material on project site which, in opinion of Engineer, is not equal to that approved for use.

B. Handle materials to keep them clean during placement. Remove and replace any dirty material or wash under technical direction of media supplier.

C. Support Gravel Installation:
   1. Handle gravel outside of bed in bag form. Carry bags into bed or open bags at operating floor and slide material down a chute onto a protected area of filter bottom or adjacent gravel layer. Pneumatic or hydraulic transfer of gravel will not be permitted.
   2. Place layers of gravel carefully by hand to avoid damage to filter bottoms and disturbance to previously placed layers, and to assure free passage of water.
   3. Complete each layer before starting next.
   4. Do not stand or walk directly upon gravel in a layer which has material less than 1/2-inch in diameter. Place boards to sustain workmen's weight without displacing gravel.
   5. Remove any gravel which becomes mixed and replace with new material in specified layers.
   6. Backwash gravel at direction of media supplier's representative to remove dirt, dust, or finer accumulations.
   7. Obtain correct thickness of each layer of gravel by marking a continuous level line on side of filter box. Level layer against a water surface held at appropriate mark.
      a. Submerge all particles to at least half their size.
      b. Have no places where gravel can be placed without particles extending more than one half their volume above water surface.
      c. Level gravel to plus or minus 1/4-inch of water surface for gravel sizes less than 1/2-inch.

D. Mixed Media Installation:
   1. Handle silica sand outside bed in bag or bulk form. Deposit sand by hand, hydraulically or pneumatically. When placing hydraulically or pneumatically, place through water of sufficient depth to prevent sand from disturbing top layer of gravel.
   2. Upon completion of placement of silica sand, thoroughly backwash sand, beginning with a very slow rate of wash and increasing gradually until bed is expanded about 30 percent. Wash for approximately 15 minutes. Initial backwash rates, gradual increases and maximum rate in accordance with AWWA B 100 Section 4.1.2. Adjust as required for density and effective size of silica sand specified.
   3. After backwashing, drain bed and remove fines from top of bed.
   4. Backwash filter again, and remove any additional fines.
   5. Repeat process until surface of bed is satisfactory to Engineer.
   6. If top of sand is not at prescribed depth in filter, remove excess sand or add clean sand. If additional sand is added, backwash the filter and remove fines as specified above until approved by Engineer. If sand is to be removed, do so by coring to 75 percent of full depth in sufficient number of areas to reduce levels to prescribed height. Redistribute sand and backwash.

7. Place anthracite upon silica sand in a manner similar to procedure specified for silica sand.
8. After anthracite has been deposited backwash filter and remove fines and dust by skimming. A minimum of two backwashings and skimmings required.
9. Obtain proper level of anthracite in manner similar to silica sand.

E. During gravel and media placement it is critical that air in washwater mains and underdrain system is released prior to introduction of washwater for media placement. Air in system can cause media to be upset requiring removal and reinstallation of media. In order to minimize this potential, adhere to following:
1. Check operation of washwater pumps and all air release/vacuum and butterfly valves prior to installation of any filter media. Verify proper control of filter washwater valves and filter rate of flow controllers, either manually or via instrumentation system.
2. Operate valves very slowly during flushing of underdrain system and subsequently during washing of any filter media.
3. After first cracking open valves and allowing water to flow into underdrain system, allow adequate time for air to escape from underdrain system at that flow rate prior to opening valves farther and increasing rate of flow. Incremental movement of valves should not exceed 5 percent, particularly until valve has been opened to approximately 25 percent range and it is obvious that all air has been removed from system.
4. Whenever possible, allow water to remain in underdrain system or even in gravel layer of filter media between washes. This will minimize amount of air that gets into underdrain system and reduce subsequent turbulence during initial part of backwash cycle.

F. Use extreme care in backwashing filter to prevent any possible upsets of filter gravel, high density sand, sand, or granular activated carbon. Should an upset occur, in which gravel is dislodged from its position and mixed with silica sand or silica sand is anthracite, even in smallest area of filter, remove filter media and replace it in prescribed manner at no additional cost to Owner.

G. After all media has been placed and brought to specified gradation, fill entire filter with water and maintain in this condition until disinfection takes place.

3.03 DISINFECTION

A. After all work is completed, and before filters are placed in service, disinfect each filter in accordance with Section 01658 and as follows:
1. Inject sufficient chlorine into washwater to produce a solution having a chlorine concentration of at least 25 mg/l throughout filter.
2. Keep chlorinated water in filter for a minimum of 24 hours.
3. After disinfection, backwash filter to remove chlorinated water until chlorine residual in filter water is 2 mg/l.
4. Maintain 2 mg/l chlorine in filter water until filter is placed in service.

3.04 FIELD QUALITY CONTROL

A. Manufacturers Field Services:
   1. Have media supplier provide services of an experienced qualified technician to continuously supervise installation of media systems during installation of media in first filter. After installation of media in all filters is complete, have supplier certify that media was installed in a proper manner, meets gradation requirements, and is approved by them.
   2. Submit supplier's certificate stating media was installed in accordance with Specifications, meets graduation requirements, and is approved by them.

END OF SECTION

SECTION 13224

FILTER UNDERDRAIN SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Requirements for filter underdrain system in each of the six (6) filter boxes as shown on the Drawings and specified herein. Five (5) filter boxes are to be equipped as part of Phase 1 construction and one (1) filter box is to be equipped as part of Phase 2 construction.

B. Related Specification Sections:
   1. Section 03600 - Grout.
   2. Section 13222 - Filter Media.

C. Alternates:
   1. Low profile underdrain as manufactured by Roberts Water Technologies.
   2. Type SL underdrain as manufactured by F. B. Leopold Company, Inc.

1.02 SYSTEM DESCRIPTION

A. Filter underdrain and header/lateral air wash system to be installed in the following:

Filters	Phase 1	Phase 2
Type	Dual cell, center gullet filters with washwater/effluent flume in the center of each cell.	Dual cell, center gullet filters with washwater/effluent flume in the center of each cell.
Number - Filters - Cells per filter	 5 2	 1 2
Dimensions - Filter Cell Length, feet - Filter Cell Width, feet - Filter Cell Area, sq. feet - Filter Area, each Filter, sq. feet - Total Area, All Filters, sq. feet	 27.0 13.0 351 702 3,510	 27.0 13.0 351 702 702

B. Backwash:
   1. Water:
      a. Provide uniform water distribution at maximum and minimum flow rates, at no greater than head loss stated.
      b. Maximum backwash flow rate, gpm/sq.ft. - 25.0

c. Minimum backwash flow rate, gpm/sq.ft. - 4.0
d. Maximum backwash head loss, feet - 2.7
e. Maximum filtration rate, gpm/sf - 6.0

2. Air Wash:
   a. Fixed grid header lateral system
   b. Flow rate, scfm/sq.ft. - 3.0
   c. Maximum pressure drop, psi - 2.5

1.03 SUBMITTALS

A. Submit in accordance with these Specifications, shop drawings for the filter underdrain system demonstrating compliance with these Specifications, including:
   1. Manufacturer's descriptive literature, specifications and engineering data defining filter underdrain materials, dimensions, construction, weight and flow rate versus pressure.
   2. Layout drawing of filter underdrain system and air piping.
   3. Manufacturer's test records from an independent hydraulic laboratory, demonstrating the equalization of backwash flow under conditions at least equivalent to the layout for this project.

B. Furnish in accordance with these Specifications manufacturer's installation certificate for all underdrain and air piping.

C. Submit installation procedure for air wash equipment including coordination of installation with filter media.

1.04 QUALITY ASSURANCE

A. The filter underdrain and air wash system units shall be essentially the standard products of a manufacturer who has been regularly engaged in the successful production of high quality filter underdrain systems of this type for at least ten (10) years, and has supplied these systems for at least five (5) years of the ten (10) year period and has at least five (5) installations in successful operation for at least five (5) years.

B. The filter underdrain system shall be a PVC or polyethylene underdrain system as specified herein and shown on the Drawings. The filter airwash system and piping shall be a header/lateral pipe and diffuser system as specified herein and shown on the Drawings.

C. Have underdrain supplier provide services of a factory-trained manufacturer's representative to continuously supervise complete erection and testing of filter underdrain system in first filter. After installation of underdrain system in all filters is complete, and before media is installed in the filter, have manufacturer certify that underdrain was installed in a proper manner and is approved by them.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle the filter underdrains in accordance with the manufacturer's recommendations, and as supplemented herein:
   1. Do not store or place any other units or materials on top of the filter underdrains.
   2. Store filter underdrains in heated room. Do not allow temperature to drop below 32 degrees F.

PART 2 PRODUCTS

2.01 UNDERDRAINS AND AIR WASH

A. Filter underdrain blocks shall be of the low profile tri-lateral type made of extruded PVC (Roberts) or high density polyethylene (Leopold).

B. Underdrain block joints designed such that leakage will not occur in joint with up to a 2 degree joint misalignment.

C. Filter underdrain system designed to insure long-term stability in operating characteristics.
   1. Underdrain system designed to withstand filter media and hydraulic forces created when filter is backwashed at 25 gal./sq. ft./min.

D. All filter underdrains shall be uniform and smooth in construction with all holes open and smooth, and the underdrains shall be constructed entirely in a first-class manner with no cracks or imperfections. All underdrains not meeting the requirements will be rejected.

E. The air wash header, distribution laterals and diffusers shall be of type 304 stainless steel.

F. Manufacturer:
   1. The filter underdrain and air wash system shall be designed and manufactured by one of the following:
      a. Roberts Water Technologies, Darby, PA; Low Profile Underdrain and fixed air grid.
      b. The F.B. Leopold Company, Inc.,Zelienople, PA, Type SL Underdrain and fixed air grid.

2.02 GROUT

A. Sand and cement for grout shall meet Section 03600 Specifications.

PART 3 EXECUTION

3.01 PRE-INSTALLATION INSPECTION

A. Check all underdrain products for defects and damage, and reject those not meeting specifications or that are damaged.

B. Check to ensure sand and cement for grouting are free from foreign materials and meet grouting specifications.

C. Inspect filter boxes to verify that all debris have been removed and the surfaces have been properly prepared to receive the new underdrain.

3.02 CLEANING

A. Clean filter boxes of all debris, dirt and other foreign material and flush with clean water before installing grout and underdrain.

3.03 INSPECTION-GENERAL

A. Install and test the underdrain system under supervision of manufacturer's representative.

B. Check to ensure sand and cement for grouting are free from foreign materials and meet grouting specifications.

3.04 INSTALLATION (ROBERTS WATER TECHNOLOGIES)

A. Strike a grade line on the filter wall 6-1/2 inches above the high point of the floor.

B. Screed a layer of bed grout 1/2 inch thick and of sufficient width (approximately 12 inches) for the entire length of the basin in a flat level plane to accommodate a single run of block.

C. If the floor slab has been consolidated to produce a hard smooth surface, it is recommended that the installer scrabble the surface of the floor slab and wet the roughened surface with a fine spray of suitable bonding agent prior to laying any bed grout. This will ensure a complete adhesion between the grout and the floor slab.

D. The LP laterals are installed as complete lateral runs, parallel to and starting against one of the filter walls. Each lateral run should be started by centering the flume openings over the flume, otherwise dimensional variations in the filter walls may cause problems in locating the laterals.
   1. Locate the side of the lateral parallel to the side wall of the filter. Here it may be necessary to "butter" the side wall of the block where it contacts the wall. The completed lateral should be dimensionally located away from the end wall of the filter in accordance with the drawings. An end plate has been installed to cover the end of the block. Grout is inserted between the end plate and the filter wall

taking care the grout does not penetrate between the plate and the block. Now apply pressure to level the entire lateral into the bed grout. Gentle tapping with a rubber mallet may also be done.

2. When the entire lateral has been bedded and leveled, grout should be placed between the end plates and the filter wall.
3. Continue with the next adjacent completed lateral. Where blocks span the flume, a PVC bridge is located across the flume and against the side of the previously bedded lateral. These strips prevent grout from falling into the flume when the space between laterals is being filled. Force these into the mortar until the bottom of the grout strips flush with the bottom of the previously laid block. This presents a smooth bottom in the flume for an uninterrupted flow of water during backwash. Take care the grout strips and laterals are carefully centered over the flume.
4. As installation progresses, sections partially completed should be protected using heavy building paper, vinyl sheeting or other acceptable covering to maintain cleanliness until final placement of filter media.
5. Continue bedding adjacent laterals until only four runs are left. Reverse position and bed two runs adjacent to the filter basin wall opposite from the first run. This will leave two runs yet to be placed. Allow the bed mortar to set sufficiently to allow walking on the laterals without displacement.
6. Carefully, working on top of the suitably protected block, place the last two block runs in the manner described above.

E. After the entire filter underdrain has been set into the bed mortar, grouting of the spaces between each lateral can begin. Carefully grout the space between laterals to prevent grout from blocking the orifices. Be certain the grout flows completely around the securement ribs located on each side of the LP Underdrain lateral.

F. In the event that a lateral becomes cracked following completed installation, a PVC welder should be used to seal the crack. If additional material is required to repair the damage, the complete lateral must be removed and replaced.

G. The spaces between the runs and blocks should be troweled flush to the top of the LP Underdrain surface.

H. Air wash header and laterals shall be coordinated with the installation of the gravel system and shall be in accordance with the manufacturer's recommendation.

3.05 INSTALLATION (F.B. LEOPOLD)

A. Preparation: Strike a caulk line around the filter walls as a guide, 8-3/4-inches above the spot on the filter. Use a transit when installing the laterals to assure the underdrains being level to 1/8-inch over the entire filter bottom. Take rod readings at three (3) points along every lateral run.

B. Assembly of Laterals: Assemble laterals and stack in filters prior to installation. Install within three days of assembly and in the case of varying temperature the same day of assembly.
   1. Assembly is similar to a push-on joint pipe assembly. A manufacturer applied sealant covered with protective tape encapsulates the bell and spigot ends of the laterals. Remove the protective tape.
   2. Set the 7/32 and ¼-inch O-ring gaskets in the appropriate positions on the spigot end of the pipe. Spray bell and spigot ends completely with a silicone lubricant. The lubricant shall be as recommended by the block manufacturer.
   3. Use the external assembly tool to pull the adjacent lateral blocks together taking care to keep the O-rings gaskets in the grooves.

C. Setting the Laterals: Set the entire length of the lateral in a bed of ¾ inch thick base grout. Grout to be one (1) part cement to two (2) parts sand. Prior to setting the grout, scrabble the concrete surface to assure a bond. End plates furnished by the manufacturer to be in place prior to the lateral installation. After setting all laterals, allow base grout to setup for 24-hours prior to placing grout between laterals, and lateral and walls. The lateral must be leveled to a tolerance of +/- 1/8". With 4 rows remaining, reverse position and bed two runs adjacent to the opposite filter basin wall. Allow mortar to set sufficiently to allow walking on the block without displacement. Cover installed blocks before walking on them. Install two remaining internal rows. Allow the filter underdrain to set for at least three (3) days and covered for protection.

3.06 INSPECTION

A. After the underdrain has been set and grouted, check the underdrains to insure that all top surface orifices in each underdrain are open and free of debris.

B. If possible, enter the flume and visually check each run for cleanliness and freedom from grout run-ins and deposits which would interfere with flow. Remove accumulations with a scraper type tool.

C. In the event hardened grout or debris should clog a dispersal orifice during installing, care must be taken in removing the obstruction from the orifice. Carefully remove the obstruction from the orifice by using a 3/16-inch diameter carbide tipped bit with an electric drill. Gently work the carbide tip bit through the clogged orifice taking care to keep the bit from significantly enlarging the orifice and/or fracturing the block.

D. Three (3) days (or longer) after the grouting has been completed and before any gravel is placed, test the filter underdrain system.

3.07 TESTING

A. Close all filter valves except the wash valve.

B. Throttle back the flow control on the backwash line to 1/3 normal setting (approximately 5-gpm/sf) and start backwash. Slowly fill the filter to release entrapped air.

C. As filter begins to fill, check all grouted joints for water jets which indicate possible problem areas.

D. When the water level has reached a height of 6-inches above underdrains, discontinue wash, and drain just until the water falls below the underdrain surface.

E. Start the slow backwash again and compare the water jetting from the dispersal orifices. These jets should be of approximately equal heights. If not, drain unit and check all dispersal orifices for clogging.

F. Repeat steps 4 and 5 until all problem areas have been identified and corrected.

G. Repair any problem joints by carefully chiseling out defective material and re-patching.

H. Allow repaired areas to set for at least three (3) days and repeat testing as above.

I. After the above tests, make another visual inspection of the bottom, and if satisfactory, begin installing support gravel and filter media in accordance with Section 13222 - Filter Media.

J. If gravel is not placed immediately after testing, place plastic sheeting over the entire surface to prevent dirt from entering the orifices and to eliminate additional cleaning at a later date.

K. Test the air header lateral air distribution system for uniformity of distribution in accordance with the manufacturer's recommendation.

END OF SECTION

SECTION 13225

FIBERGLASS-FILTER WASHWATER TROUGHS

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes: Provision of fiberglass filter washwater troughs in each filter box, complete with stainless steel fasteners and mounting hardware as shown on Drawings and specified. Six (6) filter boxes with a total of twelve (12) cells are to be equipped. Five (5) filter boxes are to be equipped in Phase 1 construction and one (1) filter box is to be equipped in Phase 2 construction.

B. Related Sections:
   1. Submittals: Section 01300.
   2. Products: Section 01600.
   3. Basic Equipment Materials and Methods: Section 11005.

1.02 REFERENCES

A. NSF International:
   1. NSF 61 Listings, Drinking Water Additives - Health Effects.

1.03 SYSTEM DESCRIPTION

A. Design Requirements: Provide four (4) fiberglass washwater troughs in each filter cell, eight (8) in each filter, complete with all appurtenant accessory equipment as indicated on Drawings.

B. Performance Requirements:
   1. General: Arrangement of trough assemblies is shown on Drawings. Provide standardized parts wherever possible, for interchangeability.
   2. Each assembly designed to withstand a suddenly applied upward buoyant water load. Conversely, each assembly designed to withstand a full water load in assemblies.
      a. Trough construction such that vertical deflection under maximum loading and vibration does not exceed 1/32 inch variation from level over entire span. Troughs capable of carrying a full load of water without buoyant support.
      b. Reinforcing methods such that loading or vibrations over long periods of time will not cause permanent creep in excess of above tolerances.
      c. Flanged attachment middle and end hangers and supports as shown on Drawings.

1.04 SUBMITTALS

A. Shop Drawings: Submit shop drawings for Fiberglass Washwater and Collection Troughs in accordance with Section 01300 and Section 11005, demonstrating compliance with specifications. Include following:
   1. Manufacturer's literature, illustrations, specifications, and engineering data defining material, dimensions and weights.
   2. Method of Installation. Mounting as shown on Drawings. Submit design calculations indicating compliance with deflection criteria as herein specified.

B. Quality Assurance/Control Submittals:
   1. Trough manufacturer to furnish test results from a nationally recognized independent testing facility verifying nontoxicity of materials used in manufacture of troughs. NSF 61 Certification listing acceptable for compliance with this requirement.

1.05 QUALITY ASSURANCE

A. Washwater troughs to be essentially standard products of a manufacturer who has been regularly engaged in successful production of high quality fiberglass troughs of this type for at least ten years, has supplied such troughs for at least five years of ten year period, and has at least five installations in successful operation for at least five years.

1.06 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle fiberglass troughs in accordance with these Specifications, manufacturer's recommendations, and as supplemented herein:
   1. Store troughs so they will not warp or deflect.
   2. Do not store other troughs or materials on top of any trough.

B. See Section 01600 for general handling, storage and protection requirements.

1.07 PROJECT CONDITIONS

A. Coordinate openings in concrete walls with requirements for troughs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Manufacturers
   1. The F. B. Leopold Company, Inc., Zelienople, PA
   2. Roberts Water Technologies, Darby, PA
   3. Warminster Fiberglass

2.02 MATERIALS

A. Washwater Troughs

1. Washwater troughs constructed of fiberglass reinforced polyester resin laminates of dimensions and shape shown on Drawings. Comply with following:
   a. Minimum thickness: 1/4 inch
   b. Sandwich construction reinforcing of end grain balsa across bottom and in sides.
   c. Turned back edges molded as an integral part of the unit.
   d. Lateral stiffness and rigidity provided through use of Type 304 stainless steel spreaders placed at strategic points along length and fastened to troughs with stainless steel hardware. Spreaders located above flowline in trough when filter is being washed at 25 gallons per minute per square foot.
   e. Back end of troughs provided with a fiberglass closure integrally molded with trough. Closure at least 1-1/2 times thickness of wall.
2. Structural steel trough reinforcement encapsulated in fiberglass. Drawings show longitudinal angle stiffeners, and reinforcement plates at end of troughs. Manufacturer to review Drawings, and add, delete or modify reinforcement where necessary to satisfy Specification deflection and vibration requirements. Stiffeners and reinforcement plates welded together, not bolted to troughs, but are to be an integral part of trough. No bolting of accessories through stiffener will be allowed.
3. Smooth, resin rich inner surfaces, reinforced with glass surfacing mat, followed with a minimum of three ounces of chopped strand glass laminate in a minimum of two layers. No other glass product permitted between these layers. Final laminate thickness within a tolerance of plus 1/16 inch and minus 0 inch. Void content of completed laminate not to exceed 2-1/2 percent of laminate by volume.
4. Outer surface of troughs reasonably smooth with no glass fibers exposed. Size and number of air bubbles held to a minimum. Dense laminations without voids, dry spots, cracks, or crazes.
5. All cut or machined edges and drill holes coated with resin to fill all voids. No exposed glass fiber or steel.
6. Color: Blue-green translucent. Ultraviolet absorbance of resin not to exceed 0.25 percent.

B. Metal Attachments
   1. Type 304 stainless steel bolts, nuts, threaded rods, washers, anchors, spreaders, stabilizers, and saddles.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine all items immediately prior to installation. All surfaces to be smooth, free of warping, vertical deflections greater than 1/32-inch, cracks, voids, porosity, dry spots, crazes, and unreinforced areas. Raw or machined edges covered with a coating of rich resin.

B. Repair or replace damaged items as directed by Engineer, at no additional cost to Owner. Have only factory trained manufacturer's representative perform repair work.

3.02 INSTALLATION

A. Install and assemble in complete conformance with manufacturer's instructions.

B. Exercise care in erecting and leveling the troughs. Maintain weir edges level and straight without more than 1/8 inch variation from level and in horizontal alignment throughout the entire assembly.

3.03 FIELD QUALITY CONTROL

A. Site Tests:
   1. Fill filter box with water to top of washwater troughs. Check vertical and horizontal conformance with Specifications.
   2. Backwash filter with and without air wash in operation. Check vertical and horizontal conformance with Specifications. Check for visible vibration.

B. Manufacturers Field Services:
   1. Provide factory-trained manufacturer's representative for a minimum of 2 days to supervise erection and testing of troughs, inspect completed installation, and place in operation.
   2. Have manufacturer's representative check and approve installation before initial operation.
   3. After each site test, have manufacturer's representative make all adjustments required to have washwater troughs conform to Specification tolerances under all operating conditions.
   4. Have manufacturer's representative instruct plant personnel on care and maintenance of washwater troughs and accessories.
   5. Furnish manufacturer's installation certificate in accordance with these Specifications.

END OF SECTION

SECTION 13410

PROCESS MONITORING AND CONTROL SYSTEM

PART 1 GENERAL REQUIREMENTS

1.01 SUMMARY

A. Section Includes: The work specified in this Section consists of the supply of material, the installation, and testing of the Process Monitoring and Control System herein designated as PMCS.

B. Materials supplied under this section:
   1. None

C. Products supplied but not installed under this section:
   1. None

D. Products installed but not supplied under this section:
   1. Iconics Genesis32 Software (Supplied by Owner)

E. Related Sections:
   1. Instruments: Section 13420
   2. Instrument Enclosures and Control Panels: Section 13430
   3. Programmable Logic Controllers: Section 13451
   4. Human-Machine Interface: Section 13455
   5. Basic Electrical Requirements: Division 16 Sections

F. PMCS Contractor
   1. All PMCS work is to be provided by a single Contractor.
   2. The Contractor shall provide work described in this Section and related Sections.
   3. Qualification:
      a. The Contractor must have successfully completed at least three or more PMCS projects, similar to the work described in this Section and the related Sections, in the last three years.
      b. The Contractor must have successfully completed PMCS projects of a similar size and complexity as described in this Section and the related Sections.
   4. The following Contractors are pre-approved for this project:
      a. Bristol Babcock of Watertown, CT.
      b. Industrial Control Systems of Sandston, VA.
      c. Integrated Engineering, Indianapolis, IN.

1.02 REFERENCES

A. Instrument Society of America (ISA):
   1. S5.1, Instrumentation Symbols and Identification (NRC ADOPTED).

2. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
3. RP55.1, Hardware Testing of Digital Process Computers, Recommended Practice.
4. S5.3 Graphic Symbols for Distribution Control/Shared Display Instrumentation, Logic and Computer Systems.
5. RP7.3, Quality Standards for Instrument Air.

B. National Electrical Manufacturers Association (NEMA): NEMA 250-85, Enclosures for Electrical Equipment (1,000 Volts Maximum).

C. Underwriters Laboratory Inc. (UL): UL 508, Standards for Safety, Industrial Control Equipment.

D. Deutsche Industrie-Norm (DIN), VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.

E. National Fire Code, National Fire Protection Association (NFPA): 820, Fire Protection in Wastewater Treatment Plants.

F. National Fire Code, National Fire Protection Association (NFPA): 70, National Electric Code.

1.03 DEFINITIONS

A. Abbreviations:
1. ANSI - American National Standards Institute.
2. FAT - Factory Acceptance Test.
3. HMI - Human Machine Interface.
4. IEEE - Institute of Electrical and Electronic Engineers.
5. ISA - Instrument Society of American Standards.
6. I&C - Instrumentation and Control.
7. I/O - Input and Outputs.
8. JIC - Joint Industrial Council.
9. NEC - National Electrical Code.
10. NEMA - National Electrical Manufacturers Association.
11. OSHA - Occupational Safety and Health Act.
12. O&M - Operation and Maintenance.
13. PC - Personal Computer.
14. PMCS – Process Monitoring and Control System.
15. P&ID - Piping and Instrumentation Diagram.
16. PLC - Programmable Logic Controller.
17. UL - Underwriter's Laboratories, Inc.
18. CSA - Canadian Standards Association.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Work Day: 8 hours of actual work.

D. Software:
   1. Programming of digital devices using all types of programming language.
   2. Configuring of digital devices using all types of configuring process.
   3. Programs or configuration data stored in read only memory, programmable read only memory, read/write memory, disk, tape, or other storage device.

E. Types of Software:
   1. Standard Software: Software packages that are independent of project on which they are used. Standard software includes system software and process monitoring and control software.
   2. System Software: Application independent software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; programming languages such as FORTRAN, PASCAL, C, and BASIC; assemblers; file management utilities; text editors; debugging aids; and diagnostics.
   3. Process Systems Software: Software packages independent of specific process control project on which they are used. Includes, but is not limited to, providing capability for, data acquisition, monitoring, alarming, human-machine interface, data collection, data retrieval, trending, report generation, control, and diagnostics.
   4. Application Software:
      a. Software to provide functions unique to this Project and that are not provided by standard software alone.
      b. Configuring data bases, tables, displays, reports, parameter lists ladder logic, and control strategies required to implement functions unique to this Project.

F. Rising/Falling: Terms used to define action of discrete devices about their set point.
   1. Rising: Contacts close when an increasing process variable rises through set point.
   2. Falling: Contacts close when a decreasing process variable falls through set point.

G. Signal Types:
   1. Analog Signals, Current Type:
      a. 4 to 20 mA dc signals conforming to ISA S50.1.
      b. Unless otherwise indicated for specific PMCS Subsystem components, use the following ISA 50.1 options:
         1) Transmitter Type: Number 2, two-wire.
         2) Transmitter Load Resistance Capacity: Class L.
         3) Fully isolated transmitters and receivers.
   2. Analog Signals, Voltage Type: 1 to 5 volts dc within panels where a common high precision dropping resistor is used.
   3. Discrete signals, two-state logic signals using 120V ac sources as indicated.
   4. Pulse Frequency Signals:
      a. Direct current pulses whose repetition rate is linearly proportional to process variable.
      b. Pulses generated by contact closures or solid state switches as indicated.

c. Power source less than 30V dc.

5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SCOPE OF WORK

A. General

This Section covers the furnishing and installation of a process instrumentation and control system for the Kentucky American Pool 3 Water Treatment Plant (WTP). The Kentucky American Pool 3 WTP is a new water treatment plant with a new Raw Water Pump Station located on the Kentucky River, Pool #3. The new facility will have a design capacity of 20 MGD expandable to 30 MGD. The PLC system for this project shall be based on the Bristol Inc. ControlWave PLC and the Iconics Genesis32 Human Machine Interface (HMI) software package.

Primary devices include pressure switches and cells, level probes and flow elements. Transmitters include electronic type for flow, level and analysis. Process indicators, controllers, control switches and status lights are included on control panels.

Wash and backwash sequence control for the filters and other control functions shall be provided through a distributed control system (DCS). The control system shall be a distributed control unit (DCU) based system

All analog, control, status and alarm signals required for alarm, display and report generation shall be transmitted to the DCS. The man-machine interface (MMI) computer system shall be a multi-tasking microcomputer (PC) based system.

All alarms shall be programmed with an adjustable time delay. All alarm setpoints and time delays shall be displayed on the HMI Graphics.

All analog analyzers shall be trended.

All flows shall be totalized (current day, current month, previous day and previous month).

All runtimes for the Raw Water Pumps, Distribution Pumps, Backwash Pumps and Air Blower shall be totalized and displayed on the HMI Graphics.

B. Requirements

1. Provide the following equipment and services required under this Section and related sections:
   a. Required Submittals.
   b. Equipment as indicated on the Project Drawings.

c. Instructions, details, and recommendations to, and coordination with, Contractor for Certificate of Installation.
d. Verify readiness for operation.
e. Verify the correctness of final power and signal connections (lugging and connecting).
f. Adjusting and calibrating.
g. Starting up.
h. Testing and coordination of testing.
i. Training.

C. Interconnections Coordination
1. Verify the following work not provided by the PMCS Contractor is provided:
a. Correct type, size, and number of signal wires with their raceways.
b. Correct electrical power circuits and raceways.
c. Correct size, type, and number of related pipes, valves, fittings, and tubes.
d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.

D. Equipment Coordination
1. For equipment not provided under this section, but directly connected to equipment required by PMCS:
a. Obtain from provider, manufacturers' information on installation, interface, function, and adjustment.
b. Coordinate with provider to allow required interface and operation with PMCS.
c. For operation and control, verify that installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
d. Test to demonstrate required interface and operation with PMCS.
e. Examples of items in this category, but not limited to the following:
1) Valve operators, position switches, and controls.
2) Motor control centers and switch gear.
3) Adjustable speed drive systems.
4) Packaged process control systems.
f. Examples of items not in this category:
1) Internal portions of equipment provided under Division 16 - Electrical, that are not directly connected to equipment required under PMCS.
2) Internal portions of package process control systems that are not directly connected to equipment provided under this section.

1.05 SUBMITTALS

A. Submit documentation to the Engineer in accordance with the applicable provisions of Section 01330 and as specified herein.

B. Submit shop drawings for the system which is documented in accordance with Instrument Society of America (ISA) Standard ISA-S5.1/.2/.3/.4.
   1. Product Data: For each electrical component, include manufacturers descriptive literature; product specifications; published details; technical bulletins; performance and capacity rating curves, charts, and schedules; catalogue data sheets; and other submittal materials as required to verify that the proposed products conform to the quality and function ability of the specified products.
   2. Identification: Clearly indicate by an arrow on submissions covering more than one product type or style exactly which product is being submitted for approval.
   3. Equipment Characteristics: Size, location, weight, and electrical requirements.
   4. Manufacturer: Include the catalogue name, company name, address, and telephone number for each product submitted.

C. Submit a copy of the Factory Acceptance Test Plan and Schedule four (4) weeks prior to the Factory Acceptance Test.

D. Submit a copy of the PLC program with documentation four (4) weeks prior to the Factory Acceptance Test. The documentation shall include the following:
   1. Tag name
   2. Section Headers
   3. Description of I/O Point
   4. Rung Addressing
   5. Cross Referencing

E. Submit the follow at least four (4) weeks prior to the Factory Acceptance Test.
   1. Color prints of HMI screens on 8 1/2 x 11 inch paper.
   2. HMI Database on 8 1/2 x 11 inch paper.
   3. Scripts developed for the screen displays.
   4. Diagram showing how screens are linked together.

F. The PMCS Contractor shall provide the electrical contractor approved drawings for all interconnection wiring between control panels and all field devices.

G. Submit copies of the Installation, O & M manual for equipment supplied within two (2) weeks prior to start up and final acceptance test. The submission and approval of this manual is considered to be an integral part of furnishing and delivery of the system equipment. Include the following elements in each manual in addition to all submittal items listed above.
   1. Erection and installation sequence and instructions.
   2. Exploded view drawings and illustrations with sequence description for assembly and disassembly of equipment.
   3. Comprehensive parts and materials list for each equipment element indicating manufacturer and manufacturer's identification number. Include name, address, and telephone number of sales and service office nearest to the final destination of the PMCS, for each major equipment item.

4. Schedules of recommended spare parts to be stocked, including part number, inventory quantity, and ordering information.
5. Performance rating and nameplate data for each major system component.
6. Procedures for starting, operating, adjusting, calibrating, testing, and shutting-down system equipment.
7. Emergency operating instructions and trouble-shooting guide.
8. Schedule of routine maintenance requirements and procedures, and preventative maintenance instructions required to insure satisfactory performance and equipment longevity.
9. Maintenance instructions for extended out-of-service periods.
10. Complete listing of all software programming.
11. Complete Operator's Supervisors Manual for the Control System which includes system hardware and software, and the 'how too' of the system.
12. Testing Reports.
13. ISA Data Sheets, filled out to reflect final field instrument calibration.
14. "As-built" drawings of control panels, wiring, instruments, etc. Final as-built drawing shall be provided on 3 1/2-inch disks in AutoCAD format.
15. Provide PLC programs with tag database on 3 1/2-inch disks.
16. Provide HMI documentation as follows:.
    a. Color prints of HMI screens on 8 1/2 x 11 inch paper.
    b. HMI Database on 8 1/2 x 11 inch paper.
    c. Scripts developed for the screen displays.
    d. Diagram showing how screens are linked together.

1.06 QUALITY ASSURANCE

A. The drawings and specifications are based on instrumentation and control equipment manufactured by the first named manufacturer. Any changes to the structure, piping, electrical work, etc., required for other approved manufactures shall be borne by the PMCS Contractor in accordance with Section 01630 of these Specification. The Contractor shall submit drawings to the Engineer for approval, showing changes in the equipment, piping, structure and electrical work.

B. All components (i.e. hardware, software, etc.) of the PMCS shall be the most current proven design available at the time of installation of the system. The Contractor shall provide a warranty for all PMCS components for a period of one year after start up and owner acceptance. In addition, the Contractor shall provide software upgrades for a period of one year after plant start up and owner acceptance at no additional cost to the Owner. All components shall be suitable for the intended application and shall be installed and wired in strict accordance with the manufacturer's requirements.

C. The PMCS equipment shall be the standard products of a manufacturer who has been regularly engaged in the successful production of high quality equipment and systems of the type specified for at least 10 years, has supplied such equipment for at least five years of the ten year period, and has at least three similar system installations in successful operation for at least five years.

D. The Contractor shall assume complete system responsibility for the adequate and proper operation of all equipment furnished regardless of original source or manufacturer. The Contractor shall submit a detailed project management proposal with the bid, including staffing and resumes of the project management team assigned to this project. The Contractor's project team shall include a Project Manager, who will be the key contact person. The team shall include a Project Site Supervisor, who will provide on site assistance during installation, start-up and training. The Project Site Supervisor shall be responsible for starting up the complete system and providing on site training of the Owner's supervisors, operators and service technicians. The Contractor shall submit with the bid, a reference list of at least three similar system installations, including the name and location of the facility, the name and location of the Engineer, and the name and telephone number of at least one member of the facility supervisory personnel completely familiar with the installation and operation of the system. In addition, two sets of drawings for a completed system shall be submitted with the proposal. The project management proposal will be submitted to the office of the Engineer prior to the bid. The Contractor shall submit the Project Management Proposal a minimum of 14 days prior to bid opening to be given consideration.

E. A Factory Acceptance Test (FAT) shall be performed to demonstrate the complete operational capabilities of the system hardware and software, utilizing simulated inputs and outputs, on an open loop basis. The Contractor shall furnish the Engineer with a copy of the FAT Plan, at least four (4) weeks prior to the scheduled FAT. The Contractor shall furnish the Engineer with a copy of the punch list from the factory demonstration, at test completion. The testing shall simulate all operating conditions, including steady-state, start-up, shutdown, and power failure conditions. The Owner and Engineer shall be notified, at least four (4) weeks in advance, of the schedule for the factory demonstration. The Owner and Engineer shall provide their own travel and subsistence to visit the Contractor's factory to observe the factory demonstration. During the visit the Contractor shall demonstrate the system and testing shall be based on the submitted Factory Acceptance Test Plan and Schedule. The factory test shall demonstrate all graphics, report generation and alarm functions of the system. Witness testing shall not, in any way, relieve the Contractor from conforming to the requirements set forth in the Contract Documents.

F. Submit a statement listing any deviations from or exceptions to these specifications as prescribed in the Instructions to Bidders. Include specification reference and proposed alternative, with reasons stated for deviations or exceptions for review by the Engineer. Reference to a particular equipment model of a named manufacturer is made only to identify a particular equipment design, style, and arrangement. The Contractor is completely responsible to provide equipment which fully satisfies the mechanical and electrical integrity, materials quality, and functional intent established by the specifications. Products, components, and materials prescribed throughout the specifications constitute the Engineer's acceptable level of quality. Modifications to a manufacturer's standard design may be required to meet these specifications. Equipment not complying with the mechanical, electrical, and material integrity

established by these specifications will not be acceptable as determined by the Engineer.

G. A meeting shall be scheduled and attended within thirty (30) days after the award of the Contract to coordinate all aspects of the design, fabrication, delivery, installation and start-up of the PMCS system. In attendance shall be representatives of the Contractor (and as required, any of their major equipment suppliers), Owner, and Engineer. Subsequent meetings shall be scheduled, as required, to assure timely completion and start-up of the PMCS. Meetings will be held at the office of the Owner. The Contractor shall be prepared to discuss:
   1. Equipment Shop Drawing Submittal Schedule
   2. Loop Drawing Submittal Schedule
   3. Controller Logic Program Submittal Schedule
   4. Wiring Diagram Submittal Schedule
   5. Factory Acceptance Test Plan and Schedule
   6. Equipment Delivery Schedule
   7. Start-up Schedule

1.07 DELIVERY STORAGE AND HANDLING

A. Store all PMCS equipment and accessories specified in this Section, which are delivered to the project site prior to the time the Contractor is ready to install them, as specified in Section 01660. Verify from the Manufacturer the maximum and minimum temperature and maximum relative humidity for storing the equipment, and conform to the Manufacturer's requirements. In any case, the minimum storage requirements will be those specified in Section 01660 and the minimum storage temperature shall not be less than 50 degrees F. Protect the equipment from humid conditions which might cause corrosion of the electrical and electronic parts of the equipment. Failure to store equipment in the specified or approved manner shall be sufficient reason for not accepting the equipment, regardless of the outside appearance or warranty of the manufacturer. Protect all electronic equipment from a dusty environment by sealing the equipment in plastic, etc.

1.08 PROJECT/SITE CONDITIONS

A. Environmental Design Requirements: The following defines certain types of environments. PMCS Subsystems refer to these definitions by name to specify the environments requirements for individual equipment units.
   1. Inside, Air Conditioned:
      a. Temperature:
         1) Normal: 60 to 80 degrees F.
         2) With Up to 4-Hour HVAC System Interruptions: 40 to 105 degrees F.
      b. Relative Humidity:
         1) Normal: 10 percent (winter) to 70 percent (summer).
         2) With Up to 4-Hour HVAC System Interruption: 10 to 100 percent.
      c. NEC Classification: Non-hazardous.

2. Inside:
   a. Temperature: 20 to 104 degrees F.
   b. Relative Humidity: 10 to 95 percent non-condensing.
   c. NEC Classification: Non-hazardous.
3. Inside, Corrosive:
   a. Temperature: Minus 20 to 104 degrees F.
   b. Relative Humidity: 10 to 95 percent non-condensing.
   c. Corrosive Environment: Chlorine gas/sodium hypochlorite.
   d. NEC Classification: Non-hazardous.
4. Inside, Hazardous:
   a. Temperature: Minus 20 to 104 degrees F.
   b. Relative Humidity: 10 to 95 percent non-condensing.
   c. NEC Classification: Class 1, Division 1, Group D.
5. Outside:
   a. Temperature: Minus 20 to 104 degrees F.
   b. Relative Humidity: 10 to 100 percent rain, snow, freezing rain.
   c. NEC Classification: Non-hazardous.
6. Outside, Corrosive:
   a. Temperature: Minus 20 to 104 degrees F.
   b. Relative Humidity: 0 to 100 percent, rain, snow, freezing rain.
   c. Corrosive Environment: Chlorine gas.
   d. NEC Classification: Non-hazardous.
7. Outside, Hazardous:
   a. Temperature: Minus 20 to 104 degrees F.
   b. Relative Humidity: 0 to 100 percent rain, snow, freezing rain.
   c. NEC Classification: Class 1, Division 1, Group D.

1.09 WARRANTY

A. The Contractor shall provide a warranty for all PMCS equipment for a period of one (1) year after start-up and Owner acceptance.

1.10 SYSTEM CONTROL CONCEPT

A. The purpose of the System Control Concept is to provide a written description of how the process equipment should be monitored and controlled by the PMCS.

B. Refer to Appendix A for the complete System Control Concept text.

PART 2 PRODUCTS

2.01 SPARE PARTS

A. Provide spare parts as specified in this section and the related sections.

B. Furnish the following spare parts for the instrumentation equipment provided in this Section.
   1. One box of every size and type fuse.
   2. Three of each type of signal optical isolator and surge suppressor.

C. Furnish the following spare parts for the DCS equipment and control panels provided in this Section.
   1. Two of each type of plug in I/O board.
   2. Two spare power supplies of each type.
   3. Twenty-four spare relays of each type.
   4. One spare switch and pushbutton of each type.
   5. Ten percent, but not less than 100 of each type of light bulb and not less than 12 of each fuse provided, including the computer, monitor and printer.
   6. Six spare ribbon cartridges for each dot matrix printer and three spare black and color cartridges for each inkjet printer.
   7. Two Ethernet communications cards.
   8. Two boxes (5,000 sheets per box) of printer paper for each type of printer provided. Paper shall be in addition to that used during testing and start up.
   9. One of each type of pressure switch, premounted on seals where applicable.

D. Furnish the following instrumentation test equipment:
   1. One Fluke Model 743B, Process Signal Calibrator with three pressure modules:
      a. 0-100 inches H_2O
      b. 0-830 inches H_2O
      c. 0-250 psig
   2. One Beamax pneumatic pump for pressure/vacuum calibration.

E. Furnish the following spare parts and test equipment for the fiber optic system:
   1. Optical test power meter - 2 pieces.
   2. 12 Type ST connectors with termination kit.
   3. Two Optic Switches.

F. Furnish a recommended spare parts and test equipment list for all equipment furnished in this Section as part of the required operations and maintenance manual submittal. The list shall include recommended tools and spare parts associated with the following items:
   1. Remote telemetry units (DPC-3330) (i.e., spare mother boards, etc.)
   2. Input and output boards.
   3. 24 VDC power supplies.
   4. Modems.
   5. RTU related tools.
   6. Electrical testing equipment (such as digital multimeter, logic tester, signal loop calibrator.

7. Instrumentation buyouts, i.e., pressure transmitters, flow transmitters, etc.

PART 3 EXECUTION

3.01 FACTORY ACCEPTANCE TEST

A. The Owner and Engineer shall witness a complete Factory Acceptance Test of the entire control system prior to its shipment to the job site.

B. The Factory Acceptance Test shall not be performed until certification that the individual PMCS component hardware testing had been successfully completed.

C. The Factory Acceptance Test shall be conducted by the Contractor using simulated inputs and outputs to demonstrate that all the system hardware and application software are functioning according to the intent of the plans and specifications. The test plan shall include simulated system faults and failures.

D. The Factory Test shall also demonstrate all graphics, report generation and alarm functions of the system.

E. The Engineer shall provide written approval for shipment of the system following the acceptance of the properly functioning system demonstrated during the Factory Acceptance Test.

F. Provide at least a two week written notification to the Engineer prior to the start of the witnessed factory test.

3.02 INSTALLATION

A. Install the electrical work of this section only under the supervision of licensed electricians.

B. Install equipment as shown on the Drawings and approved shop drawings and as directed by the manufacturer's representative.
   1. Mount enclosures on 1/4-inch (6mm) spacers or U-channel supports to provide a space between enclosures and mounting surfaces.
   2. Provide supports as specified in Section 16070, Hangers and Supports.
   3. Set the top of enclosures 6'-6" above the finished floor or grade unless otherwise indicated or specified.

C. Install enclosure conduit and wiring:
   1. Remove knock-outs or punch holes in the enclosures for conduit entries.
      a. Connect conduit to enclosures with water-tight hubs except as follows:
         1) In dry locations, either the watertight hubs or two locknuts and bushings may be used to connect conduits to the disconnect switch enclosure.

2) In damp locations, either the watertight hubs or a sealing locknut, interior locknut, and grounding bushing may be used on the bottom of the enclosures.

2. Remove or protect components installed in the interior of enclosures during wire pulling.
3. Use lugs provided by or approved by the manufacturer of the terminating device to connect wiring to the enclosure terminals in conformance with Section 16122, Low-Voltage Wire, Cable, and Accessories.

3.03 FIELD QUALITY CONTROL

A. Site Testing:
   1. Prior to energizing the low-voltage enclosures:
      a. Perform insulation testing and ensure that all power wiring is clear of shorts in accordance with the requirements of Section 16080, Electrical Testing.
   2. Final testing after energizing the enclosure:
      a. Perform the thermographic test (if required) in conformity with Section 16080, Electrical Testing, and record the circuit parameters.

3.04 FIELD TESTING

A. Calibrate all equipment to the ranges as indicated in the equipment specification, including the zero and span settings as required. Follow all manufacturer's requirements and procedures for the calibration. Calibrate and test all equipment in the presence of the Engineer, or his duly authorized representative.

B. Provide the service of a factory-trained serviceman to verify that instruments have been properly installed, configured, and meet the manufacturer's qualifications for warranty.

C. Conduct field loop checks for all 4-20 mA DC loops using a simulator in order to test the control system and final control element response. Provide corrective measures to remove any ground loops found during start-up.

D. Provide all final equipment calibration and testing in report form as part of the Contractors Installation, Operation, and Maintenance Manual. All final calibration data is to be submitted on ISA Specification Forms, ISA S.20-1981.

E. Test all automatic control loops, in the field, and demonstrate successful performance of the control logic, final control elements, and process measurements, before placing into final service. Provide these tests in the presence of the Engineer or his duly authorized representative.

F. The Contractor shall test all HMI graphic screens, in the field, and demonstrate successful performance of the software, before placing into final service. The Contractor shall adjust, tune, debug, and commission all software and parameters for controlled systems to assure proper operation in accordance with the System Control

Concept and database tables. Provide these tests in the presence of the Engineer or his duly authorized representative.

G. Provide a Contractor's representative on site during Preliminary and Final Mechanical Performance Testing.

3.05 COMMISSIONING

A. No electrical energy is to be applied to any PMCS equipment or components prior to receipt of the Installation Certificate. The Contractor's service engineer must initiate operation of the equipment.

B. Provide the supervisory service of a factory-trained serviceman, who is specifically trained on the types of equipment herein specified, for a minimum period of [3] 8-hour days during construction to assist the Contractor in the location of sleeves, methods of installing conduit and special cable; mounting, piping, and wiring of one of each type of device; and the methods of protecting all of the equipment prior to placing it into service.

C. Upon completion of the installation, provide the services of the above serviceman for minimum of [3] days for adjustment, calibration, and start-up of the equipment. After acceptance of the Final Performance Test, provide the above serviceman for minimum of [3] days to instruct the plant operators in the operation and maintenance of the control systems. Have the serviceman return to the plant [1] time, at two month intervals for one year after written acceptance of the Final Mechanical Performance Tests, for a period of one day each. During each visit, the serviceman shall review the plant operation, correct deficiencies, and check maintenance procedures. The days specified above represent a minimum time, but does not relieve the Contractor of providing sufficient service to place the complete PMCS in satisfactory operation, as determined by the Engineer, and maintain it that way for one year.

D. Installation Certificate: Submit a certificate from the manufacturer, or from the manufacturer's qualified, factory-authorized representative, stating that the installed equipment has been inspected, adjusted, approved, and certified to be satisfactory prior to initial mechanical performance testing.

3.06 FINAL PERFORMANCE AND ACCEPTANCE TEST

A. Provide the services of a factory trained and field experienced engineer to assist the Owner's personnel during the start-up of the process. The purpose of this assistance is to support making final adjustments of settings on the PMCS prior to performing the demonstrations and final operational testing. Notify the Engineer in writing, a minimum of five (5) working days prior to the proposed date for commencing the Final Performance and Acceptance Test.

B. Upon completion of instrument calibration and system verification, test all systems under process conditions. The intent of this test is to demonstrate and certify the operational interaction of the PMCS. Testing shall include, but not limited to, taking process variables to their limits (simulated or actual process) to verify all alarms, failure interlocks and/or transfers, and operational interlocks.

C. Immediately correct defects and malfunctions with Engineer approved methods and materials, and repeat the test. Upon completion of the final operational testing, submit the test results and a certified report indicating that all required PMCS tests have been completed satisfactorily and the systems meet the functional requirements of their applicable specifications.

D. Following final operational testing, the PMCS shall operate without a system fault for 30 consecutive days to qualify for Final Acceptance. The Final Performance and Acceptance Tests shall be witnessed, documented and signed off upon satisfactory completion by the Engineer.

3.07 TRAINING

A. Scope: This section addresses the requirements for training of the Owner's personnel with regard to operation, maintenance, and programming of the system.

B. Training Cost: The System Supplier shall pay all costs associated with training except travel and per diem expenses for the Owner's personnel. The cost of training shall be included in the contract price.

C. Training Submittal:
   1. The System Supplier shall submit a training plan to the Engineer for approval. The training plan shall include a proposed schedule, course descriptions and outlines, proposed Operator proficiency examination, and resumes and job descriptions of the trainers. The training plan shall be approved at least 30 days prior to beginning any training.
   2. The System Supplier shall coordinate all on-site training with the Engineer to accommodate shift personnel.

D. Training Requirements:

In general, the System Supplier's standard training courses shall be utilized to meet the training specified herein. Where a System Supplier's standard courses do not meet the specified training, the System Supplier shall develop and provide additional course work. Any training the operators receive during system start-up or calibration of field instrumentation, RTU's or any process sub-system shall not meet the requirements of this section of the Specifications.

Training shall be given either at the System Supplier's factory or on-site, as dictated by the table below. Training requirements for each audience are summarized in the table below:

Audience	Instruction Days Per Student	Number of Students	Maximum Students/ Presentation	Minimum Trainer Days	Minimum Student Days	Location	Occurrence
*Operator	10	4	2	20	40	On-Site	As Scheduled
Maintenance	7	6	2	21	42	On-Site	As Scheduled
Programmer	5	8	2	20	40	Factory	As Scheduled
Manager	7	2	2	7	14	On-Site	As Scheduled
Supervisor	7	2	2	7	14	On-Site	As Scheduled

TOTALS				75	150		

* Does not include start-up work

An instruction day is defined as eight hours of instructor platform time. A student day is defined as eight hours of an individual student's class attendance time. The System Supplier shall provide at least 45 instruction days for a total of 314 student days. Twenty instruction days shall be presented on-site. Twenty instruction days shall be presented at the Supplier's factory. Training for each audience is described below.

1. Operator Training: Operator training shall be provided by the System Supplier. This training shall equip operators with the skills necessary to operate the Owner's system. As a minimum, the operator training program shall provide operators with the ability to do the following:
   a. Use workstations and keyboards.
   b. Retrieve and interpret all standard displays including graphics, overview displays, group displays, trends, point summaries, and alarm summaries.
   c. Enter data manually.
   d. Change control parameters and set points.
   e. Assume manual control of equipment and control it from the screen.
   f. Print reports.
   g. Acknowledge alarms.
   h. Respond to software and hardware error.
   i. Historical Data Collection, archival and retrieval.
   j. Capabilities and configurability of: reports, alarm reporting, setting passwords, system hardware configuration.
   k. Database back-up and recovery.

The operator training program shall be provided on a separate training system so as not to interfere with system start-up. The training system shall be of the same manufacture and software release as the system being supplied to the Owner. The training system shall be configured specifically for water applications. The operator training program shall include at least 50% hands-on instruction and shall be designed for personnel with no prior computer experience. The System Supplier shall provide a standard System Operator's Guide and a course manual for each student. Student course manuals shall include copies of all overheads used by the instructor, as well as detailed hands-on exercise instructions. An examination shall be administered to the Operators during the training session.

2. Maintenance Training: Maintenance training shall be provided by the System Supplier. This training shall equip technicians with the skills necessary to diagnose, trouble shoot and repair the components of the Owner's system provided by the System Supplier. As a minimum, the maintenance training program shall provide technicians with the ability to do the following:
   a. Power-up, bootstrap, and shut down of all hardware devices.
   b. Perform scheduled maintenance functions on all components.
   c. Describe theory of operation of all circuit boards.

d. Set up and use off-line diagnostics to determine hardware failures to the fault board or module.
e. Use workstations and keyboards to retrieve and interpret displays which provide on-line diagnostic information.
f. Remove and replace all removable boards/modules.

The maintenance training program shall be provided on a separate training system so as not to interfere with system start-up. The training system shall be of the same manufacture as the system being supplied to the Owner. The maintenance training program shall include at least 50% hands-on instruction and shall be designed for personnel who have electronics maintenance and repair experience and a general knowledge of computer systems, but shall not assume any familiarity with the specific hardware furnished.

The System Supplier shall provide a standard System Maintenance Manual and a course manual for each student. Student course manuals shall include copies of all overheads used by the instructor, as well as detailed hands-on exercise instructions.

3. Programmer Training: Programmer training shall be provided by the System Supplier. This training shall equip the Owner's personnel with the skills necessary to initially configure and reconfigure the Owner's system. As a minimum, this training program shall provide programmers with the ability to do the following:
   a. Perform all operator level functions.
   b. Create and define all custom and standard displays including graphics, overview displays, group displays, trends, point summaries, alarm summaries, and event summaries.
   c. Configure historical data collection parameters.
   d. Design, build, and schedule reports.
   e. Configure alarm reporting parameters.
   f. Configure system security.
   g. Configure the laboratory data entry package.
   h. Archive/Retrieve historical data.
   i. Create and edit the system database.
   j. Add new filed I/O points to the system.
   k. Add new computers and computer devices to the system.
   l. Perform system software and database backup/recovery functions.
   m. Create and define control algorithms.

   The programmer training program shall be provided at the System Supplier's factory using standard factory courses. The programmer training program shall include at least 50% hands-on instruction. It shall be designed for personnel who are generally familiar with process control computers and high-level application programs, but not familiar with the specific system furnished.

   The System Supplier shall provide standard System Engineer's Guides and course manuals for each student for each course. Student course manuals shall include copies of all overheads used by the instructor, as well as detailed hands-on exercise instructions.

4. Manager Training: Manager training shall be provided by the System Supplier. This training shall equip the Owner's personnel with the knowledge necessary to make informed decisions about system configuration. It shall also equip the Owner's management personnel with the basic skills necessary to get around in the system, determine process statuses, and print reports. As a minimum, this training program shall cover the following topics:
   a. Use of workstations and keyboards.
   b. Retrieval and interpretation of all standard displays.
   c. Basic process control using the system.
   d. Capabilities and configurability of the following:
      1) Historical data collection, archival, and retrieval
      2) Reporting
      3) Alarm reporting
      4) System security
      5) Laboratory data package
      6) System hardware configuration
      7) Control algorithms
   f. Software and database backup and recovery.

   The management training program shall be provided on a separate training system so as not to interfere with system start-up. The training system shall be of the same manufacture and software release as the system being supplied to the Owner. The training system shall be configured specifically for water applications. The management training program shall be designed for personnel who are generally familiar with computers and high-level application programs, but not familiar with the specific system furnished. The management training program shall include at least 60% hands-on instruction.

   The System Supplier shall provide a standard System Operator's Guide and a course manual for each student. Student course manuals shall include copies of all overheads used by the instructor, as well as detailed hands-on exercise instructions.
5. Supervisor Training: Supervisor training is for personnel who will need to make access changes to the DCS. As a minimum, this training program shall cover the following topics:
   a. Log-on and log-off to the MMI
   b. Setting and clearing passwords
   c. Configuring access levels for various process parameters and set points
   d. Printing and configuring reports

   The supervisor training program shall be provided on a separate training system so as not to interfere with system start-up. The training system shall be of the same manufacture as the system being supplied to the Owner. The supervisor training program shall include at least 50% hands-on instruction and shall be designed for personnel with no prior computer experience.
6. The on-site training program shall be scheduled in 5-day increments (weekdays) which shall be coordinated with the Owner and Engineer. Each 5 day session

shall include any mix of full day training sessions for Operators, Maintenance Personnel and Managers. Training for each audience shall not exceed two days in any one week training period. Therefore, three training sessions per audience shall be staggered through the duration of the project:

a. Initial training.
b. Mid-project.
c. When the DCS is fully operational.

7. Operator and maintenance personnel training shall be coordinated with system start-up.

END OF SECTION