

**PROJECT MANUAL  
CONTRACT DOCUMENTS**

**THE CITY OF GREENUP  
2018 WATER TREATMENT PLANT**

**The City of Greenup**

1005 Walnut Street  
Greenup, KY 41144  
(606) 473 – 7331

Lundie Meadows – Mayor  
David Black – City Council  
Steve Branim – City Council  
Kathy Newberry – City Council  
Mark Harris – City Council  
Bruce Mantz – City Council  
Marty Stephens – City Council

**Howerton Engineering & Surveying PLLC**

Richard L. Howerton, PE, PLS, CFM  
404 Main Street  
Greenup, KY 41144  
(606) 473 - 5684

**The City of Greenup**

Approved: \_\_\_\_\_

Title: \_\_\_\_\_

Date: \_\_\_\_\_

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SECTION 00010  
ADVERTISEMENT FOR BIDS

The City of Greenup - Proposed 3mgd Actiflo Carb Water Treatment  
Plant  
Greenup, Kentucky

OWNER:       The City of Greenup

Separate sealed BIDS:

The City of Greenup - Proposed 3mgd Actiflo Carb Water Treatment  
Plant Project  
Refer to specifications and drawings.

Will be received by Mayor Lundie Meadows, at The City of Greenup,  
1005 Walnut Street, Greenup, KY 41144 until 3:00 P.M. Local Time,  
6/6/2018 and then at said office publicly opened and read aloud.

Pre-Bid meeting will be held on 05/28/2018 2:00 p.m. at The City  
of Greenup's City Building located at 10005 Walnut Street,  
Greenup, KY 41144.

Bidders are encouraged to schedule an onsite review prior to  
bidding. Please contact the city for more information.

Drawings, specifications and contract documents may be examined at  
the following places:

The City of Greenup  
1005 Walnut Street  
Greenup, KY 41144

Howerton Engineering  
404 Main Street  
Greenup, KY 41144

plans may be obtained from Key Blue Prints, Inc., 411 Elliott  
Avenue, Cincinnati, OH 45215, 614-228-3285 the cost of shipping  
and duplication from Key Blue Prints. [www.keycompanies.com](http://www.keycompanies.com).

After award of a Contract, the Contractor will be furnished,  
without charge, 6 sets of plans and 3 set of specifications needed  
to prosecute the work. Subcontractors, manufacturers, and  
suppliers shall obtain plans and specifications from the  
Contractor.

Sealed proposals shall be marked on the outside of the container  
as follows:

"The City of Greenup - Proposed 3mgd Actiflo Carb Water Treatment  
Plant Project" Not to be opened until 3:00 P.M. local time,  
6/6/2018

The following addenda have been received and considered in the  
enclosed bid: \_\_\_\_\_"



Time of Completion for the project is 540 calendar days.

If forwarded by mail, the sealed envelope containing the bid must be enclosed in another envelope and mail to the above address. Mailed bids must reach this physical address prior to the scheduled closing time for receipt of proposals.

The OWNER reserves the right to waive formalities or to reject any or all bids. Each BIDDER must deposit with his bid, security in the amount, form and subject to the conditions provided in the Instructions to Bidders.

Award of the Contract shall be made to the lowest, responsive responsible bidder. Refer to the Contract Specifications for specific requirements.

MINORITY FIRMS ARE ESPECIALLY ENCOURAGED TO BID. City of Greenup has established a local labor use goal, refer to section 00715 - Local Labor Goal.

Bids shall be accompanied by a certified check of bid bond payable to the Owner an amount no less than ten percent (10%) of the base bid. No bidder may withdraw his bid for a period of ninety (90) days after the date bids are opened. He may, however, withdraw his bid at any time prior to the time and date scheduled for opening of same or any authorized postponement thereof. Any bid received after the time and date specified will not be considered and will be returned unopened to the bidder.

Bidders must comply with the President's Executive Order Nos. 11246 and 11375, which prohibit discrimination in employment regarding race, creed, color, sex or national origin. Bidders must comply with Title VI of the Civil Rights Act of 1964, the Anti-Kickback Act, and the Contract Work Hours Standard Act. Bidders must certify that they do not and will not maintain or provide for their employees any facilities that are segregated on the basis of race, creed, color or national origin.

Technical questions concerning interpretation of the Drawings and Specifications should be addressed to Richard Howerton, PE, Howerton Engineering, 404 Main Street, Greenup, KY 41144 Telephone (606) 473-5684. All requests for interpretation shall be made in writing. Where appropriate, the response and addenda will be issued to all plan holders in writing.

"Equal Employment Opportunity"  
END OF SECTION

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## ARTICLE 1 - DEFINED TERMS

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1.01 Terms used in these Instructions to Bidders have the meanings indicated in the General Conditions and Supplementary Conditions. Additional terms used in these Instructions to Bidders have the meanings indicated below:

- A. *Issuing Office*--The office from which the Bidding Documents are to be issued and where the bidding procedures are to be administered.
- B. Other contracts are subject to Provisions of the Contract, General Provisions and Federal Contract Notes, Special Notes and KYTC Provisions and where applicable.

## ARTICLE 2 - COPIES OF BIDDING DOCUMENTS

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2.01 Complete sets of the Bidding Documents in the number and for the deposit sum, if any, stated in the Advertisement or Invitation to Bid may be obtained from the Issuing Office.

2.02 Complete sets of Bidding Documents shall be used in preparing Bids; neither Owner nor Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

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

## ARTICLE 3 - QUALIFICATIONS OF BIDDERS

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3.01 To demonstrate Bidder's qualifications to perform the Work, within five days of Owner's request, Bidder shall submit written evidence such as financial data, previous experience, present commitments, and such other data as may be called for below.

[A. Water Treatment Plants, last five years list of projects, owner, approximate project cost.]

## ARTICLE 4 - EXAMINATION OF BIDDING DOCUMENTS, OTHER RELATED DATA, AND SITE

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### 4.01 *Subsurface and Physical Conditions*

A. The Supplementary Conditions identify:

1. Those reports of explorations and tests of subsurface conditions at or contiguous to the Site that Engineer has used in preparing the Bidding Documents.

2. Those drawings of physical conditions in or relating to existing surface and subsurface structures at or contiguous to the Site (except Underground Facilities) that Engineer has used in preparing the Bidding Documents.

B. Copies of reports and drawings referenced in Paragraph 4.01.A will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.02 of the General Conditions has been identified and established in Paragraph 4.02 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any "technical data" or any other data, interpretations, opinions or information contained in such reports or shown or indicated in such drawings.

### 4.02 *Underground Facilities*

A. Information and data shown or indicated in the Bidding Documents with respect to existing 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, including Owner, or others.

#### 4.03 *Hazardous Environmental Condition*

A. The Supplementary Conditions identify those reports and drawings relating to a Hazardous Environmental Condition identified at the Site, if any, that Engineer has used in preparing the Bidding Documents.

B. Copies of reports and drawings referenced in Paragraph 4.03.A will be made available by Owner to any Bidder on request. Those reports and drawings are not part of the Contract Documents, but the “technical data” contained therein upon which Bidder is entitled to rely as provided in Paragraph 4.06 of the General Conditions has been identified and established in Paragraph 4.06 of the Supplementary Conditions. Bidder is responsible for any interpretation or conclusion Bidder draws from any “technical data” or any other data, interpretations, opinions, or information contained in

4.04 Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to subsurface conditions, other physical conditions and Underground Facilities, and possible changes in the Bidding Documents due to differing or unanticipated conditions appear in Paragraphs 4.02, 4.03, and 4.04 of the General Conditions. Provisions concerning responsibilities for the adequacy of data furnished to prospective Bidders with respect to a Hazardous Environmental Condition at the Site, if any, and possible changes in the Contract Documents due to any Hazardous Environmental Condition uncovered or revealed at the Site which was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be within the scope of the Work appear in Paragraph 4.06 of the General Conditions.

4.05 On request, Owner will provide Bidder access to the Site to conduct such examinations, investigations, explorations, tests, and studies as Bidder deems necessary for submission of a Bid. Bidder shall fill all holes and clean up and restore the Site to its former condition upon completion of such explorations, investigations, tests, and studies. Bidder shall comply with all applicable Laws and Regulations relative to excavation and utility locates.

4.06 Reference is made to Article 2 of the Supplementary Conditions for the identification of the general nature of other work that is to be performed at the Site by Owner or others (such as utilities and other prime contractors) that relates to the Work contemplated by these Bidding Documents. On request, Owner will provide to each Bidder for examination access to or copies of Contract Documents (other than portions thereof related to price) for such other work.

4.07 It is the responsibility of each Bidder before submitting a Bid to:

A. examine and carefully study the Bidding Documents, the other related data identified in the Bidding Documents, and any Addenda;

B. visit the Site and become familiar with and satisfy Bidder as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work;

C. become familiar with and satisfy Bidder as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work;

D. carefully study all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions, and (2) reports and drawings of Hazardous Environmental Conditions at the Site which have been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions;

E. obtain and carefully study (or accept consequences of not doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be

employed by Bidder, including applying any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto;

F. agree at the time of submitting its Bid that no further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of its Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents;

G. become aware of the general nature of the work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents;

H. correlate the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents;

I. promptly give Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder discovers in the Bidding Documents and confirm that the written resolution thereof by Engineer is acceptable to Bidder; and

J. determine that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work.

4.08 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 Bidding Documents and applying any specific means, methods, techniques, sequences, and procedures of construction that may be shown or indicated or expressly required by the Bidding Documents, that Bidder has given Engineer written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has discovered in the Bidding Documents and the written resolutions thereof by Engineer are acceptable to Bidder, and that the Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work.

## **ARTICLE 5 - PRE-BID CONFERENCE**

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May 28, 2018 2:00 pm at The City of Greenup's City building located at 1005 Walnut Street, Greenup, KY 41144.

## **ARTICLE 6 - SITE AND OTHER AREAS**

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6.01 The Site is identified in the Bidding Documents. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by Owner unless otherwise provided in the Bidding Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by Contractor.

## **ARTICLE 7 - INTERPRETATIONS AND ADDENDA**

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7.01 All questions about the meaning or intent of the Bidding Documents are to be submitted to Engineer in writing. 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 Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

7.02 Addenda may be issued to clarify, correct, or change the Bidding Documents as deemed advisable by Owner or Engineer.

## **ARTICLE 8 - BID SECURITY**

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8.01 A Bid must be accompanied by Bid security made payable to Owner in an amount of 5 percent of Bidder's maximum Bid price and in the form of a certified check or bank money order or a Bid bond (on the form attached) issued by a surety meeting the requirements of Paragraphs 5.01 and 5.02 of the General Conditions.

8.02 The Bid security of the Successful Bidder will be retained until such Bidder has executed the Contract Documents, furnished the required contract security and met the other conditions of the Notice of Award, whereupon the Bid security will be returned. If the Successful Bidder fails to execute and deliver the Contract Documents and furnish the required contract security within 15 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 earlier of seven days after the Effective Date of the Agreement or 61 days after the Bid opening, whereupon Bid security furnished by such Bidders will be returned.

8.03 Bid security of other Bidders whom Owner believes do not have a reasonable chance of receiving the award will be returned within seven days after the Bid opening.

## **ARTICLE 9 - CONTRACT TIMES**

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9.01 The number of days within which, or the dates by which the Work is to be substantially completed and ready for final payment are set forth in the Agreement.

## **ARTICLE 10 - LIQUIDATED DAMAGES**

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

## **ARTICLE 11 - SUBSTITUTE AND "OR-EQUAL" ITEMS**

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11.01 The Contract, if awarded, will be on the basis of materials and equipment specified or described in the Bidding Documents without consideration of possible substitute or "or-equal" items. Whenever it is specified or described in the Bidding Documents that a substitute or "or-equal" item of material or equipment may be furnished or used by Contractor if acceptable to Engineer, application for such acceptance will not be considered by Engineer until after the Effective Date of the Agreement.

## **ARTICLE 12 - SUBCONTRACTORS, SUPPLIERS, AND OTHERS**

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12.01 If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, individuals, or entities to be submitted to Owner in advance of a specified date prior to the Effective Date of the Agreement, the apparent Successful Bidder, and any other Bidder so requested, shall within five days after Bid opening, submit to Owner a list of all such Subcontractors, Suppliers, individuals, or entities proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, individual, or entity if requested by Owner. If Owner or Engineer, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, individual, or entity, Owner may, before the Notice of Award is given, request apparent Successful Bidder to submit a substitute,

[in which case apparent Successful Bidder shall submit an acceptable substitute, Bidder's Bid price will be increased (or decreased) by the difference in cost occasioned by such substitution, and Owner may consider such price adjustment in evaluating Bids and making the Contract award.]

12.02 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, individuals, or entities. Declining to make requested substitutions will not constitute grounds for forfeiture of the Bid security of any Bidder. Any Subcontractor, Supplier, individual, or entity so listed and against which Owner or Engineer makes no 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 6.06 of the General Conditions.

12.03 Contractor shall not be required to employ any Subcontractor, Supplier, individual, or entity against whom Contractor has reasonable objection.

## **ARTICLE 13 - PREPARATION OF BID**

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13.01 The Bid Form is included with the Bidding Documents. Additional copies may be obtained from Howerton Engineering.

13.02 All blanks on the Bid Form shall be completed by printing in ink or by typewriter and the Bid signed in ink. Erasures or alterations shall be initialed in ink by the person signing the Bid Form. A Bid price shall be indicated for each [section, Bid item, alternative, adjustment unit price item, and unit price item] listed therein, or the words "No Bid," "No Change," or "Not Applicable" entered.

13.03 A Bid by a corporation shall be executed in the corporate name by the president or a vice-president or other corporate officer accompanied by evidence of authority to sign. The corporate seal shall be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation shall be shown below the signature.

13.04 A Bid by a partnership shall be executed in the partnership name and signed by a partner (whose title must appear under the signature), accompanied by evidence of authority to sign. The official address of the partnership shall be shown below the signature.

13.05 A Bid by a limited liability company shall be executed in the name of the firm by a member and accompanied by evidence of authority to sign. The state of formation of the firm and the official address of the firm shall be shown below the signature.

13.06 A Bid by an individual shall show the Bidder's name and official address.

13.07 A Bid by a joint venture shall be executed by each joint venturer in the manner indicated on the Bid Form. The official address of the joint venture shall be shown below the signature.

13.08 All names shall be typed or printed in ink below the signatures.

13.09 The Bid shall contain an acknowledgment of receipt of all Addenda, the numbers of which shall be filled in on the Bid Form.

13.10 The address and telephone number for communications regarding the Bid shall be shown.

13.11 The Bid shall contain evidence of Bidder's authority and qualification to do business in the state where the Project is located or covenant to obtain such qualification prior to award of the Contract. Bidder's state contractor license number, if any, shall also be shown on the Bid Form.

## **ARTICLE 14 - BASIS OF BID; COMPARISON OF BIDS**

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14.01 *Lump Sum*

- A. Bidders shall submit a Bid on a lump sum basis for the base Bid and include a separate price for each alternate described in the Bidding Documents as provided for in the Bid Form. The price for each alternate will be the amount [added to] *[or]* [deleted from] the base Bid if Owner selects the alternate. In the comparison of Bids, alternates will be applied in the same order as listed in the Bid form.
- B. Unit Prices used in the enumeration of the form of proposal in the bid, are used to establish the LUMP SUM BID. When computing unit prices the quantities, as listed in the schedule of bid items, are estimates

only. The contractor is required to complete the work specified in accordance with the contract, whether quantities installed are greater or smaller than the estimated amounts involved.

- C. In a lump-sum contract, the contractor agrees to perform the stipulated job of work in exchange for a fixed sum of money. The satisfactory completion of the work for the stated contract amount remains the obligation of the contractor, regardless of the difficulties and troubles experienced in the course of the construction activities. Once the contract is executed, the only way to change the contract price is to issue a change order.

## **ARTICLE 15 - SUBMITTAL OF BID**

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15.01 With each copy of the Bidding Documents, a Bidder is furnished one separate unbound copy of the Bid Form, and, if required, the Bid Bond Form. The unbound copy of the Bid Form is to be completed and submitted with the Bid security and the following data:

- [A. Bid Bond or certified check in amount not less than 5% of total Base Bid]
- [B. Bidder's qualifications]
- [C. Major subcontractor listing]
- [D. Authentication of bid and statement of non-collusion and non-conflict of interest]
- [E. Debarred firms certification]
- [F. Project References Listing]

15.02 A Bid shall be submitted no later than the date and time prescribed and at the place indicated in the Advertisement or Invitation to Bid and shall be enclosed in an opaque sealed envelope plainly marked with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted), the name and address of Bidder, and shall be accompanied by the Bid security and other required documents. If a Bid is sent by mail or other delivery system, the sealed envelope containing the Bid shall be enclosed in a separate envelope plainly marked on the outside with the notation "BID ENCLOSED."

## **ARTICLE 16 - MODIFICATION AND WITHDRAWAL OF BID**

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16.01 A Bid 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 prior to the date and time for the opening of Bids.

16.02 If within 24 hours after Bids are opened, any Bidder files a duly signed written notice with Owner and promptly thereafter demonstrates to the reasonable satisfaction of Owner that there was a material and substantial mistake in the preparation of its Bid, that Bidder may withdraw its Bid, and the Bid security will be returned. Thereafter, if the Work is rebid, that Bidder will be disqualified from further bidding on the Work.

## **ARTICLE 17 - OPENING OF BIDS**

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17.01 Bids will be opened at the time and place indicated in the Advertisement or Invitation to Bid and, unless obviously non-responsive, read aloud publicly. An abstract of the amounts of the base Bids and major alternates, if any, will be made available to Bidders after the opening of Bids.

## **ARTICLE 18 - BIDS TO REMAIN SUBJECT TO ACCEPTANCE**

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18.01 All Bids will remain subject to acceptance for the period of time stated in the Bid Form, but Owner may, in its sole discretion, release any Bid and return the Bid security prior to the end of this period.

## **ARTICLE 19 – EVALUATION OF BIDS AND AWARD OF CONTRACT**

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19.01 Owner reserves the right to reject any or all Bids, including without limitation, nonconforming, nonresponsive, unbalanced, or conditional Bids. Owner further reserves the right to reject the Bid of any Bidder whom it finds, after reasonable inquiry and evaluation, to not be responsible. Owner may also 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. Owner also reserves the right to waive all informalities not involving price, time, or changes in the Work and to negotiate contract terms with the Successful Bidder.

19.02 More than one Bid for the same Work from an individual or entity under the same or different names will not be considered. Reasonable grounds for believing that any Bidder has an interest in more than one Bid for the Work may be cause for disqualification of that Bidder and the rejection of all Bids in which that Bidder has an interest.

19.03 In evaluating Bids, Owner will consider 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.

19.04 In evaluating Bidders, Owner will consider the qualifications of Bidders and may consider the qualifications and experience of Subcontractors, Suppliers, and other individuals or entities proposed for those portions of the Work for which the identity of Subcontractors, Suppliers, and other individuals or entities must be submitted as provided in the Supplementary Conditions.

19.05 Owner may conduct such investigations as Owner deems necessary to establish the responsibility, qualifications, and financial ability of Bidders, proposed Subcontractors, Suppliers, individuals, or entities to perform the Work in accordance with the Contract Documents.

19.06 If the Contract is to be awarded, Owner will award the Contract to the Bidder whose Bid is in the best interests of the Project.

19.07 LPA shall verify contractor (low bidder) is not on excluded party list (suspended or debarred). [www.sam.gov/portal/public/sam](http://www.sam.gov/portal/public/sam)

19.08 Project will be awarded in accordance with LPA guidelines most current addition.

## **ARTICLE 20 - CONTRACT SECURITY AND INSURANCE**

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20.01 Article 5 of the General Conditions, as may be modified by the Supplementary Conditions, sets forth Owner's requirements as to performance and payment bonds and insurance. When the Successful Bidder delivers the executed Agreement to Owner, it shall be accompanied by such bonds.

## **ARTICLE 21 - SIGNING OF AGREEMENT**

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21.01 When Owner gives a Notice of Award to the Successful Bidder, it shall be accompanied by the required number of unsigned counterparts of the Agreement with the other Contract Documents which are identified in the Agreement as attached thereto. Within 15 days thereafter, Successful Bidder shall sign and deliver the required number of counterparts of the Agreement and attached documents to Owner. Within ten days thereafter, Owner shall deliver one fully signed counterpart to Successful Bidder with a complete set of the Drawings with appropriate identification.

## **ARTICLE 22 - SALES AND USE TAXES**

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22.01 Owner is exempt from state sales and use taxes on materials and equipment to be incorporated in the Work. Said taxes shall not be included in the Bid. Refer to Paragraph SC-6.10 of the Supplementary Conditions for additional information.

## **ARTICLE 23 - RETAINAGE**

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23.01 Provisions concerning Contractor's rights to deposit securities in lieu of retainage are set forth in the Agreement.

## BID FORM

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## ARTICLE 1 – BID RECIPIENT

- 1.01 This Bid is submitted to:  
*The City of Greenup*  
*1005 Walnut Street*  
*Greenup, KY 41144*
- 1.02 The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with Owner in the form included in the Bidding Documents to perform all Work as specified or indicated in the Bidding Documents for the prices and within the times indicated in this Bid and in accordance with the other terms and conditions of the Bidding Documents.

## ARTICLE 2 – BIDDER'S ACKNOWLEDGEMENTS

- 2.01 Bidder accepts all of the terms and conditions of the Instructions to Bidders, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for 150 days after the Bid opening, or for such longer period of time that Bidder may agree to in writing upon request of Owner.

## ARTICLE 3 – BIDDER'S REPRESENTATIONS

- 3.01 In submitting this Bid, Bidder represents that:
- A. Bidder has examined and carefully studied the Bidding Documents, the other related data identified in the Bidding Documents, and the following Addenda, receipt of which is hereby acknowledged.

<u>Addendum No.</u>	<u>Addendum Date</u>
_____	_____
_____	_____
_____	_____

- B. Bidder has visited the Site and become familiar with and is satisfied as to the general, local and Site conditions that may affect cost, progress, and performance of the Work. –
- C. Bidder is familiar with and is satisfied as to all federal, state and local Laws and Regulations that may affect cost, progress and performance of the Work.
- D. Bidder has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in SC-4.02, and (2) reports and drawings of Hazardous Environmental Conditions that have been identified in SC-4.06.
- E. Bidder has obtained and carefully studied (or accepts the consequences for not doing so) all additional or supplementary examinations, investigations, explorations, tests, studies and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Bidder, including applying the specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents to be employed by Bidder, and safety precautions and programs incident thereto.
- F. Bidder does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance of the Work at the price(s) bid and within the times and in accordance with the other terms and conditions of the Bidding Documents.
- G. Bidder is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Bidding Documents.

- H. Bidder has correlated the information known to Bidder, information and observations obtained from visits to the Site, reports and drawings identified in the Bidding Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Bidding Documents.
- I. Bidder has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Bidder has discovered in the Bidding Documents, and the written resolution thereof by Engineer is acceptable to Bidder.
- J. The Bidding Documents are generally sufficient to indicate and convey understanding of all terms and conditions for the performance of the Work for which this Bid is submitted.
- K. Bidder will submit written evidence of its authority to do business in the state where the Project is located not later than the date of its execution of the Agreement.

#### **ARTICLE 4 – FURTHER REPRESENTATIONS**

4.01 Bidder further represents that:

- A. this Bid is genuine and not made in the interest of or on behalf of any undisclosed individual or entity and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation;
- B. Bidder has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid;
- C. Bidder has not solicited or induced any individual or entity to refrain from bidding; and
- D. Bidder has not sought by collusion to obtain for itself any advantage over any other Bidder or over Owner.

## ARTICLE 5 – FORM OF PROPOSAL

### **BASE BID: 3 MGD ACTIFLO CARB WATER TREATMENT PLANT**

BIDDER agrees to perform all the work described in the CONTRACT DOCUMENTS, PLANS, and TECHNICAL SPECIFICATIONS for the following lump sum price.

The BIDDER agrees to furnish, pay for and install all plant, labor, materials, equipment, and incidentals necessary for the construction, testing, and placing into operation of the 3 mgd Actiflo Carb Water Treatment Plant, all in accordance with the drawings and specifications, for the lump sum price as shown below, which shall constitute the total bid.

The owner will award based on the lowest, best, bonafide, qualified base bidder. The owner reserves the right to reject any and all bids. Additionally.

The bidder agrees to furnish all materials, supplies, and services required for the above referenced project, as described in the specifications, contract documents, and shown on the drawings, enumerated below and as modified by the addenda list above.

---

(WORDS)

(\$

(FIGURES)

---

### **ALTERNATE EQUIPMENT**

The specifications require the use of certain equipment by specified manufacturers for the BASE BID. This requirement is not intended to restrict competition but is for the purpose of establishing the desired standard of quality and mechanical features without ruling out comparable competitive equipment which may have certain superior or inferior features not affecting the basic operation of the equipment.

Where appropriate, provisions are made here for the BIDDER to offer comparable equipment by other manufacturers for the Owner's consideration. Equipment items listed as "A" items shall be used in each BIDDER'S Base Bid. These items were used by the Engineer as the basis of design for this project. Where such are shown, equipment items listed as "B" items are the pre-approved alternates for which the BIDDER shall submit his additions or deductions to the Base Bid for supplying those alternate items. The contract award will be based on the lowest (and most qualified, City reserves the right to select any of the bids regardless if they are the lowest bidder) amount lump sum bid after additions or deductions of any "B" item alternate, or alternate bid item and/or deductive bid item that may or may not be selected by the owner and/or engineer. The owner reserves the right to select any, all, or none of the proposed "B" alternatives.

Other equipment alternates may be submitted by the bidder by listing the alternate equipment name and amount of the addition or deduction to the base bid in the space noted for "C" items. Any alternate listed as a "C" item addition or deduction will not be used to select the lowest total amount lump sum base bid. The owner and the engineer shall review proposed "C" item additions or deductions within 60 days after receipt of the bids and adjust the contract price accordingly. In addition to the addition or deduction offered, the low bidder shall reimburse the engineer through the owner for any redesign and/or construction drawings required for any dimensional, electrical, SCADA and Instrumentation & controls, mechanical, geotechnical, structural or any other changes required in design to select any, all, or none of the proposed "C" alternates.

**VALVES AND HYDRANTS****(AIR-CUSHIONED SWING CHECK AND SURGE VALVE)**

A. Golden Anderson

Total Amount

---

(WORDS)

---

(Figures)

B. Ross Valve

Total Amount

---

(WORDS)

---

Add(Deduct)

B. APCO

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)

**VALVES AND HYDRANTS**

(GATE VALVES AND BUTTERFLY VALVES OTHER THAN THOSE PROVIDED WITH ACTIFLO/LEOPOLD)

A. Dezurik

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
(Figures)

B. M & H

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
Add(Deduct)

B. Mueller

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
Add(Deduct)

B. Golden Anderson

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
Add(Deduct)

C. Other \_\_\_\_\_

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
Add(Deduct)

**STATIC IN-LINE MIXER**

A. Koflo

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
(Figures)

B. Lightnin

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
Add(Deduct)

C. Other \_\_\_\_\_

Total Amount

\_\_\_\_\_  
(WORDS)

\_\_\_\_\_  
Add(Deduct)



**VERTICAL TURBINE PUMPS****(HIGH SERVICE AND BACKWASH PUMPS)**

A. Grundfos

Total Amount

---

(WORDS)

---

(Figures)

B. Peerless

Total Amount

---

(WORDS)

---

Add(Deduct)

B. Goulds

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)

**FILTER CONTROL UNDERDRAIN BLOWER SYSTEM**

A. Leopold

Total Amount

---

(WORDS)

---

(Figures)

B. Tetra Severn Trent

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)

**CHEMICAL FEED EQUIPMENT**

A. Prominent

Total Amount

---

(WORDS)

---

(Figures)

C. Other 

---

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other 

---

Total Amount

---

(WORDS)

---

Add(Deduct)

**CHEMICAL STORAGE TANKS**

A. Assman

Total Amount

---

(WORDS)

---

(Figures)

B. Snyder

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other 

---

Total Amount

---

(WORDS)

---

Add(Deduct)

**LABORATORY FURNITURE**

A. Collegedale Casework, Inc.

Total Amount

---

(WORDS)

---

(Figures)

C. Other 

---

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other 

---

Total Amount

---

(WORDS)

---

Add(Deduct)

**PRE-ENGINEERED STRUCTURE**

A. Butler

Total Amount

---

(WORDS)

---

(Figures)

B. Varco-Pruden

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)**PLANT INSTRUMENTATION AND CONTROL SYSTEMS**

A. CI Thornburg.

Total Amount

---

(WORDS)

---

(Figures)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)**FIELD INSTRUMENTATION**

A. CI Thornburg.

Total Amount

---

(WORDS)

---

(Figures)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)

**VARIABLE FREQUENCY DRIVES**

A. Allen-Bradley

Total Amount

---

(WORDS)

---

(Figures)

B. Square D

Total Amount

---

(WORDS)

---

Add(Deduct)

B. Siemens

Total Amount

---

(WORDS)

---

Add(Deduct)

C. Other

Total Amount

---

(WORDS)

---

Add(Deduct)**ALTERNATE BID ITEM NO. ONE**

Alternate Bid Item No. One will include the deletion of the installation of the proposed Leopold filters and controls described in the specifications and shown on the drawings, and the addition of TONKA filters and controls. Bidder shall indicate if price given is an "ADD" or a "DEDUCT" to the lump sum base bid price.

---

Dollars

(WORDS)

(ADD)(DEDUCT)

---

(FIGURES)**DEDUCTIVE ALTERNATE NO. ONE**

Deductive alternate bid no one will include the deletion of the installation of ASPHALT PAVING on the site as indicated on the contract drawings and specifications within the contractor's lump sum base bid for this portion of the related work. In completing DEDUCTIVE ALTERNATE NO. ONE, the bidder shall complete both the words and figures below

---

Dollars

(WORDS)

---

(FIGURES)

## ARTICLE 6 – TIME OF COMPLETION

- 6.01 Bidder agrees that the Work will be started within ten (10) calendar days after receipt of Notice to Proceed and will be substantially complete within 540 calendar days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions and will be completed and ready for final payment in accordance with Paragraph 14.07.B of the General Conditions within 15 calendar days after the date when the Contract Times commence to runs.
- 6.02 Bidder accepts the provisions of the Agreement as to liquidated damages in the event of failure to complete the Work within the Contract Times.

## ARTICLE 7 – ATTACHMENTS TO THIS BID

- 7.01 The following documents are attached to and made a condition of this Bid:
- A. Required Bid security in the form of 5%
  - B. List of Proposed Subcontractors
  - C. List of Proposed Suppliers
  - D. List of Project References
  - E. Required Bidder Qualification Statement with Supporting Data
  - F. Local Labor Goal (Section 00715)

## ARTICLE 8 – DEFINED TERMS

- 8.01 The terms used in this Bid with initial capital letters have the meanings stated in the Instructions to Bidders, the General Conditions, and the Supplementary Conditions.

## ARTICLE 9 – BID SUBMITTAL

- 9.01 This Bid submitted by:

If Bidder is:

### An Individual

Name (typed or printed): \_\_\_\_\_

By: \_\_\_\_\_ (SEAL)  
*(Individual's signature)*

Doing business as: \_\_\_\_\_

### A Partnership

Partnership Name: \_\_\_\_\_ (SEAL)

By: \_\_\_\_\_  
*(Signature of general partner – attach evidence of authority to sign)*

Name (typed or printed): \_\_\_\_\_

A Corporation

Corporation Name: \_\_\_\_\_ (SEAL)

State of Incorporation: \_\_\_\_\_

Type (General Business, Professional, Service, Limited Liability): \_\_\_\_\_

By: \_\_\_\_\_  
(Signature – attach evidence of authority to sign)

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_  
(CORPORATE SEAL)

Attest: \_\_\_\_\_  
(Signature of Corporate Secretary)

Date of Qualification to do business in \_\_\_\_\_ [State Where Project is Located] is \_\_\_\_\\_\_\_\_\\_\_\_\_.

A Joint Venture

Name of Joint Venturer: \_\_\_\_\_

First Joint Venturer Name: \_\_\_\_\_ (SEAL)

By: \_\_\_\_\_  
(Signature of first joint venture partner – attach evidence of authority to sign)

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_

Second Joint Venturer Name: \_\_\_\_\_ (SEAL)

By: \_\_\_\_\_  
(Signature of second joint venture partner – attach evidence of authority to sign)

Name (typed or printed): \_\_\_\_\_

Title: \_\_\_\_\_

(Each joint venturer 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.)

Bidder's Business address: \_\_\_\_\_

Phone: \_\_\_\_\_ Facsimile: \_\_\_\_\_

Submitted on \_\_\_\_\_, 20\_\_\_\_.

State Contractor License No. \_\_\_\_\_. (If applicable)

SECTION 00420

BIDDER'S QUALIFICATIONS

Name of Bidder: \_\_\_\_\_.

The Bidder's Qualifications as required by the OWNER to be submitted are set forth herewith:

1. A permanent place of business is maintained at:

\_\_\_\_\_.

2. The following construction plans and equipment will be made available for use on this contract: (use additional pages if necessary)

\_\_\_\_\_.

\_\_\_\_\_.

\_\_\_\_\_.

3. In the event Contract is awarded to the undersigned, surety bonds will be furnished by:

\_\_\_\_\_  
(Surety Company)

Signed: \_\_\_\_\_.  
(Representative)

4. Experience of Bidder on other similar work: (Use additional pages, if necessary)

\_\_\_\_\_.

\_\_\_\_\_.

5. We now have the following jobs under contract and bonded:  
(Note - List all construction now under contract)

Job	Location	Percent Complete	Total Contract

6. We acknowledge that, if we are the apparent low bidder, we will submit to the OWNER within seven (7) calendar days following the bid opening our latest five (5) year loss history and insurance claim history, including, but not limited to, losses arising from general liability, errors and omissions/malpractice, vehicle liability, Workmen's Compensation, property damage, contract liability and any other coverages required by this Contract, a sworn statement on the OWNER's form of the experience of our officers, office management and field management personnel, all in accordance with the Special Conditions of the project Specifications and Bid Documents.

\_\_\_\_\_  
(CONTRACTOR)

By: \_\_\_\_\_.

Title: \_\_\_\_\_.

Date: \_\_\_\_\_

END OF SECTION



# SECTION 425

## MAJOR SUBCONTRACTOR LISTING

Bidding Contractor:\_\_\_\_\_

NOTE: This form must be completely filled in by Bidding Contractors. If no subcontractor is to be used on a listed item, write in the word "None" opposite the item.

NUMBER	SUBCONTRACTOR NAME, ADDRESS, PHONE, CONTACT	
1 SITEWORK CONCRETE	TYPE WORK	
	DOLLAR AMOUNT	\$
2 TRAFFIC CONTROL	TYPE WORK	
	DOLLAR AMOUNT	\$
3 PEDISTRIAN BRIDGE	TYPE WORK	
	DOLLAR AMOUNT	\$
4	TYPE WORK	
	DOLLAR AMOUNT	\$
5	TYPE WORK	
	DOLLAR AMOUNT	\$

\_\_\_\_\_  
Signature (Bidding Contractor)

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

END OF SECTION

SECTION 426  
SUPPLIER LISTING; LIST OF MATERIALS AND EQUIPMENT

Bidding Contractor: \_\_\_\_\_

NOTE: This form must be completely filled in by Bidding Contractors.

1. Bidders are hereby advised that the following list shall be filled out, complete, by lowest bidder within two (2) hours from close of official reading of bids, if bidder is to qualify for consideration.
2. No material or equipment will be considered which is not in every respect equal to that specified or indicated in Contract Documents.
3. Materials listed "as specified" will be interpreted as meaning exact item, by brand or make, as specified.

NUMBER	SUPPLIER NAME, ADDRESS, PHONE, CONTACT
1 Ready Mix Concrete Supplier	
2 Caulking and Sealants	
3 Pedestrian Bridge	
4	
5	
6	
7	
8	
9	
10	

BUY AMERICAN REQUIREMENTS

This project will be governed by the provisions of 23CFR635.410 that in accordance with the 23CFR635.410 the Owner and Contractor will follow this provision (see section General Provisions, buy American Requirements 23CFR635.410).

\_\_\_\_\_  
Signature (Bidding Contractor)

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

END OF SECTION

SECTION 427

PROJECT REFERENCES LISTING

Bidding Contractor: \_\_\_\_\_

NOTE: This form must be completely filled in by Bidding Contractors. LIST ANY REFERENCES FOR PREVIOUS JOBS OF THIS TYPE.

NUMBER	REFERENCE NAME, ADDRESS, PHONE
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

\_\_\_\_\_  
Signature (Bidding Contractor)

\_\_\_\_\_  
Title

\_\_\_\_\_  
Date

END OF SECTION

**NONCOLLUSION AFFIDAVIT**

Contract/Requisition No. \_\_\_\_\_

State of \_\_\_\_\_:

County of \_\_\_\_\_: s.s.

I state that I am \_\_\_\_\_ of \_\_\_\_\_ and that I am authorized to make this affidavit on behalf of my firm, and its owners, directors, and, officers. I am the person responsible in my firm for the price(s) and the amount of this bid.

I state that:

**(1)** The price(s) and amount of this bid have been arrived at independently and without consultation, communication or agreement with any other contractor, bidder or potential bidder.

**(2)** Neither the price(s) nor the amount of this bid, and neither the approximate price(s) nor approximate amount of this bid, have been disclosed to any other firm or person who is a bidder or potential bidder, and they will not be disclosed before bid opening.

**(3)** No attempt has been made or will be made to induce any firm or person to refrain from bidding on this contract, or to submit a bid higher than this bid, or to submit any intentionally high or noncompetitive bid or other form of complementary bid.

**(4)** The bid of my firm is made in good faith and not pursuant to any agreement or discussion with, or inducement from, any firm or person to submit a complementary or other noncompetitive bid.

**(5)** \_\_\_\_\_ its affiliates, subsidiaries, officers, directors, and employees are not currently under investigation by any governmental agency and have not in the last four years been convicted or found liable for any act prohibited by state or federal law in any jurisdiction, involving conspiracy or collusion with respect to bidding on any public contract, except as follows:

I state that \_\_\_\_\_ understands and acknowledges that the above representations are material and important, and will be relied on by \_\_\_\_\_ in awarding the contract(s)/ purchase order(s) for which this bid is submitted. I understand and my firm understands that any misstatement in this affidavit is and shall be treated as fraudulent concealment from the Purchasing Agency of the true facts relating to the submission of this bid.

\_\_\_\_\_  
(Signature)\_\_\_\_\_  
(Signatory's Name)\_\_\_\_\_  
(Signatory's Title)

SWORN TO AND SUBSCRIBED  
BEFORE ME THIS \_\_\_\_\_ DAY  
OF \_\_\_\_\_ 20\_\_\_\_

\_\_\_\_\_  
My Commission Expires \_\_\_\_\_

Notary Public

## **Certification Regarding Debarment, Suspension, and Other Responsibility Matters**

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

- a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
- b) Have not within a three year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State, or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
- c) Are not presently indicted for or otherwise criminally or civilly charged by a government entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (b) of this certification;
- d) Have not within a three period preceding this application / proposal had one or more public transactions (Federal, State, or local) terminated for cause or default; and
- e) Will not utilize a subcontractor or supplier who is unable to certify (a) through (d) above.

I understand that a false statement on this certification may be grounds for rejection of this proposal or termination of the award. In addition, under 18 USC Sec. 1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to 5 years, or both.

---

Type Name & Title of Authorized Representative

---

Signature of Authorized Representative

☐ I am unable to certify to the above statements. My explanation is attached.

**BID BOND**

Any singular reference to Bidder, Surety, Owner, or other party shall be considered plural where applicable.

---

BIDDER (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):



BID

Bid Due Date:

Project (Brief Description Including Location):

BOND

Bond Number:

Date (Not later than Bid due date):

Penal Sum: \_\_\_\_\_

(Words)

(Figures)

Surety and Bidder, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Bid Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

**BIDDER**

**SURETY**

\_\_\_\_\_  
Bidder's Name and Corporate Seal (Seal)

\_\_\_\_\_  
Surety's Name and Corporate Seal (Seal)

By: \_\_\_\_\_  
Signature and Title

By: \_\_\_\_\_  
Signature and Title  
(Attach Power of Attorney)

Attest: \_\_\_\_\_  
Signature and Title

Attest: \_\_\_\_\_  
Signature and Title

Note: Above addresses are to be used for giving required notice.

1. Bidder and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to pay to Owner upon default of Bidder any difference between the total amount of Bidder's Bid and the total amount of the Bid of the next lowest, responsible Bidder who submitted a responsive Bid as determined by Owner for the work required by the Contract Documents, provided that:

- 1.1. If there is no such next Bidder, and Owner does not abandon the Project, then Bidder and Surety shall pay to Owner the penal sum set forth on the face of this Bond, and
- 1.2. In no event shall Bidder's and Surety's obligation hereunder exceed the penal sum set forth on the face of this Bond.

2. Default of Bidder shall occur upon the failure of Bidder to deliver within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents.

3. This obligation shall be null and void if:

- 3.1. Owner accepts Bidder's Bid and Bidder delivers within the time required by the Bidding Documents (or any extension thereof agreed to in writing by Owner) the executed Agreement required by the Bidding Documents and any performance and payment bonds required by the Bidding Documents, or
- 3.2. All Bids are rejected by Owner, or
- 3.3. Owner fails to issue a Notice of Award to Bidder within the time specified in the Bidding Documents (or any extension thereof agreed to in writing by Bidder and, if applicable, consented to by Surety when required by Paragraph 5 hereof).

4. Payment under this Bond will be due and payable upon default by Bidder and within 30 calendar days after receipt by Bidder and Surety of written notice of default from Owner, which notice will be given with reasonable promptness, identifying this Bond and the Project and including a statement of the amount due.

5. Surety waives notice of any and all defenses based on or arising out of any time extension to issue Notice of Award agreed to in writing by Owner and Bidder, provided that the total time for issuing Notice of Award including extensions shall not in the aggregate exceed 120 days from Bid due date without Surety's written consent.

6. No suit or action shall be commenced under this Bond prior to 30 calendar days after the notice of default required in Paragraph 4 above is received by Bidder and Surety and in no case later than one year after Bid due date.

7. Any suit or action under this Bond shall be commenced only in a court of competent jurisdiction located in the state

in which the Project is located.

8. Notices required hereunder shall be in writing and sent to Bidder and Surety at their respective addresses shown on the face of this Bond. Such notices may be sent by personal delivery, commercial courier, or by United States Registered or Certified Mail, return receipt requested, postage pre-paid, and shall be deemed to be effective upon receipt by the party concerned.

9. Surety shall cause to be attached to this Bond a current and effective Power of Attorney evidencing the authority of the officer, agent, or representative who executed this Bond on behalf of Surety to execute, seal, and deliver such Bond and bind the Surety thereby.

10. This Bond is intended to conform to all applicable statutory requirements. Any applicable requirement of any applicable statute that has been omitted from this Bond shall be deemed to be included herein as if set forth at length. If any provision of this Bond conflicts with any applicable statute, then the provision of said statute shall govern and the remainder of this Bond that is not in conflict therewith shall continue in full force and effect.

11. The term "Bid" as used herein includes a Bid, offer, or proposal as applicable.

# Notice of Award

Dated \_\_\_\_\_

Project:	Owner:	Owner's Contract No.:
Contract:	Engineer's Project No.:	
Bidder:		
Bidder's Address: (send Certified Mail, Return Receipt Requested)		

You are notified that your Bid dated [Click here to enter a date.](#) for the above Contract has been considered. You are the Successful Bidder and are awarded a Contract for \_\_\_\_\_

\_\_\_\_\_

(Indicate total Work, alternates or sections or Work awarded.)

The Contract Price of your Contract is \_\_\_\_\_  
\_\_\_\_\_ Dollars (\$\_\_\_\_\_).

*(Insert appropriate data if Unit Prices are used. Change language for Cost-Plus contracts.)*

1 copies of each of the proposed Contract Documents (except Drawings) accompany this Notice of Award.

2 sets of the Drawings will be delivered separately or otherwise made available to you immediately.

You must comply with the following conditions precedent within [15] days of the date you receive this Notice of Award.

1. Deliver to the Owner [3] fully executed counterparts of the Contract Documents.
2. Deliver with the executed Contract Documents the Contract security [Bonds] as specified in the Instructions to Bidders (Article 20), [and] General Conditions (Paragraph 5.01) [and Supplementary Conditions (Paragraph SC-5.01).]
3. Other conditions precedent:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Failure to comply with these conditions within the time specified will entitle Owner to consider you in default, annul this Notice of Award and declare your Bid security forfeited.

Within ten days after you comply with the above conditions, Owner will return to you one fully executed counterpart of the Contract Documents.

\_\_\_\_\_  
Owner  
By: \_\_\_\_\_  
Authorized Signature  
\_\_\_\_\_  
Title

Copy to Engineer



**EJCDC  
SUGGESTED FORM OF AGREEMENT  
BETWEEN OWNER AND CONTRACTOR FOR  
CONSTRUCTION CONTRACT (STIPULATED PRICE)**

THIS AGREEMENT is by and between \_\_\_\_\_

(Owner) and \_\_\_\_\_

(Contractor). \_\_\_\_\_

Owner and Contractor, in consideration of the mutual covenants set forth herein, agree as follows:

**ARTICLE 1 - WORK**

1.01 Contractor shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows: \_\_\_\_\_

**ARTICLE 2 - THE PROJECT**

2.01 The Project for which the Work under the Contract Documents may be the whole or only a part is generally described as follows: \_\_\_\_\_

**ARTICLE 3 - ENGINEER**

3.01 The Project has been designed by  
Howerton Engineering & Surveying PLLC  
404 Main Street  
Greenup, KY 41144

(Engineer), 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 the completion of the Work in accordance with the Contract Documents.

**ARTICLE 4 - CONTRACT TIMES**

4.01 Time of the Essence

A. All time limits for Milestones, if any, Substantial Completion, and completion and readiness for final payment as stated in the Contract Documents are of the essence of the Contract.

4.02 Days to Achieve Substantial Completion and Final Payment

A. The Work will be substantially completed within 90 days after the date when the Contract Times commence to run as provided in Paragraph 2.03 of the General Conditions, and completed and ready for final payment in accordance with Paragraph 14.07 of the General Conditions within 15 days after the date when the Contract Times commence to run.

4.03 Liquidated Damages

A. Contractor and Owner 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 4.02 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. The parties also recognize the delays, expense, and difficulties involved in proving in a legal or arbitration proceeding the actual loss suffered by Owner if the Work is not 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 \$500 for each day that expires after the time specified in Paragraph 4.02 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 Time or any proper extension thereof granted by Owner, Contractor shall pay Owner \$500 for each day that expires after the time specified in Paragraph 4.02 for completion and readiness for final payment until the Work is completed and ready for final payment.

**ARTICLE 5 - CONTRACT PRICE**

5.01 Owner shall pay Contractor for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts determined pursuant to Paragraphs 5.01.A, 5.01.B, and 5.01.C below:

A. For all Work other than Unit Price Work, a Lump Sum of:

_____	(\$ _____)
(words)	(numerals)

All specific cash allowances are included in the above price and have been computed in accordance with paragraph 11.02 of the General Conditions.

B. For all Unit Price Work, an amount equal to the sum of the established unit price for each separately identified item of Unit Price Work times the estimated quantity of that item as indicated in this paragraph 5.01.B:

As provided in Paragraph 11.03 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classifications are to be made by Engineer as provided in Paragraph 9.07 of the General Conditions. Unit prices have been computed as provided in Paragraph 11.03 of the General Conditions.

UNIT PRICE WORK

<u>Item</u> <u>No.</u>	<u>Description</u>	<u>Unit</u>	<u>Estimated</u> <u>Quantity</u>	<u>Unit Price</u>	<u>Estimated</u>
---------------------------	--------------------	-------------	-------------------------------------	-------------------	------------------

TOTAL OF ALL ESTIMATED PRICES	_____	\$ _____
	(words)	(numerals)

C. For all Work, at the prices stated in Contractor's Bid, attached hereto as an exhibit.

**ARTICLE 6 - PAYMENT PROCEDURES**

**6.01 Submittal and Processing of Payments**

A. 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.

**6.02 Progress Payments; Retainage**

A. Owner shall make progress payments on account of the Contract Price on the basis of Contractor's Applications for Payment on or about the 20 day of each month during performance of the Work as provided in Paragraphs 6.02.A.1 and 6.02.A.2 below. All such payments will be measured by the schedule of values established as provided in Paragraph 2.07.A of the General Conditions (and in the case of Unit Price Work based on the number of units completed) or, in the event there is no schedule of values, as provided in the General Requirements:

1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below but, in each case, less the aggregate of payments previously made and less such amounts as Engineer may determine or Owner may withhold, including but not limited to liquidated damages, in accordance with Paragraph 14.02 of the General Conditions:

a. 50 percent of Work completed (with the balance being retainage). If the Work has been 50 percent completed as determined by Engineer, and if the character and progress of the Work have been satisfactory to Owner and Engineer, Owner, on recommendation of Engineer, may determine that as long as the character and progress of the Work remain satisfactory to them, there will be no additional retainage; and

b. No payment will be made for material storage.

2. Upon Substantial Completion, Owner shall pay an amount sufficient to increase total payments to Contractor to 90 percent of the Work completed, less such amounts as Engineer shall determine in accordance with Paragraph 14.02.B.5 of the General Conditions and less 10 percent of Engineer's estimate of the value of Work to be completed or corrected as shown on the tentative list of items to be completed or corrected attached to the certificate of Substantial Completion.

6.03 Final Payment

A. Upon final completion and acceptance of the Work in accordance with Paragraph 14.07 of the General Conditions, Owner shall pay the remainder of the Contract Price as recommended by Engineer as provided in said Paragraph 14.07.

**ARTICLE 7 - INTEREST**

7.01 All moneys not paid when due as provided in Article 14 of the General Conditions shall bear interest at the rate of 2 percent per annum.

**ARTICLE 8 – CONTRACTOR'S REPRESENTATIONS**

8.01 In order to induce Owner to enter into this Agreement Contractor makes the following representations:

A. Contractor has examined and carefully studied the Contract Documents and the other related data identified in the Bidding Documents.

B. Contractor has visited the Site and become familiar with and is satisfied as to the general, local, and Site conditions that may affect cost, progress, and performance of the Work.

C. Contractor is familiar with and is satisfied as to all federal, state, and local Laws and Regulations that may affect cost, progress, and performance of the Work.

D. Contractor has carefully studied all: (1) reports of explorations and tests of subsurface conditions at or contiguous to the Site and all drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site (except Underground Facilities) which have been identified in the Supplementary Conditions as provided in Paragraph 4.02 of the General Conditions and (2) reports and drawings of a Hazardous Environmental Condition, if any, at the Site which has been identified in the Supplementary Conditions as provided in Paragraph 4.06 of the General Conditions.

E. Contractor has obtained and carefully studied (or assumes responsibility for doing so) all additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface, and Underground Facilities) at or contiguous to the Site which may affect cost, progress, or performance of the Work or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by Contractor, including any specific means, methods, techniques, sequences, and procedures of construction expressly required by the Bidding Documents, and safety precautions and programs incident thereto.

F. Contractor does not consider that any further examinations, investigations, explorations, tests, studies, or data are necessary for the performance of the Work at the Contract Price, within the Contract Times, and in accordance with the other terms and conditions of the Contract Documents.

G. Contractor is aware of the general nature of work to be performed by Owner and others at the Site that relates to the Work as indicated in the Contract Documents.

H. Contractor has correlated the information known to Contractor, information and observations obtained from visits to the Site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

I. Contractor has given Engineer written notice of all conflicts, errors, ambiguities, or discrepancies that Contractor has discovered in the Contract Documents, and the written resolution thereof by Engineer is acceptable to Contractor.

J. The Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

## **ARTICLE 9 - CONTRACT DOCUMENTS**

### **9.01 Contents**

- A. The Contract Documents consist of the following:
1. This Agreement (pages 520-01 to 520-07, inclusive).
  2. Performance bond (pages 610-01 to 610-02, inclusive).
  3. Payment bond (pages 615-01 to 615-02, inclusive).
  4. Other bonds (pages \_\_\_\_\_ to \_\_\_\_\_, inclusive).
    - a. Certificate of Liability (pages \_\_\_\_\_ to \_\_\_\_\_, inclusive).
    - b. \_\_\_\_\_ (pages \_\_\_\_\_ to \_\_\_\_\_, inclusive).
    - c. \_\_\_\_\_ (pages \_\_\_\_\_ to \_\_\_\_\_, inclusive).
  5. General Conditions (pages 700-01 to 700-39, inclusive).
  6. Supplementary Conditions (pages 820-01 to 820-35, inclusive).
  7. Specifications as listed in the table of contents of the Project Manual.
  8. Drawings consisting of \_\_\_\_\_ sheets with each sheet bearing the following general title: \_\_\_\_\_ [or] the Drawings listed on attached sheet index.
  9. Addenda (numbers \_\_\_\_\_ to \_\_\_\_\_, inclusive).
  10. Exhibits to this Agreement (enumerated as follows):
    - a. Contractor's Bid (pages 410-01 to 410-07, inclusive).
    - b. Documentation submitted by Contractor prior to Notice of Award (pages \_\_\_\_\_ to \_\_\_\_\_, inclusive).
    - c. \_\_\_\_\_.
  11. The following which may be delivered or issued on or after the Effective Date of the Agreement and are not attached hereto:
    - a. Notice to Proceed (pages 550-01 to 550-01, inclusive).
    - b. Work Change Directives.
    - c. Change Order(s).
- B. The documents listed in Paragraph 9.01.A are attached to this Agreement (except as expressly noted otherwise above).
- C. There are no Contract Documents other than those listed above in this Article 9.
- D. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraph 3.04 of the General Conditions.

## **ARTICLE 10 - MISCELLANEOUS**

### **10.01 Terms**

A. Terms used in this Agreement will have the meanings stated in the General Conditions and the Supplementary Conditions.

### **10.02 Assignment of Contract**

A. No assignment by a party hereto of any rights under or interests in the Contract 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.

### **10.03 Successors and Assigns**

A. 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 to all covenants, agreements, and obligations contained in the Contract Documents.

### **10.04 Severability**

A. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon Owner and Contractor, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision.

IN WITNESS WHEREOF, Owner and Contractor have signed this Agreement in duplicate. One counterpart each has been delivered to Owner and Contractor. All portions of the Contract Documents have been signed or identified by Owner and Contractor or on their behalf.

This Agreement will be effective on [Click here to enter a date.](#) (which is the Effective Date of the Agreement).

OWNER:



By: \_\_\_\_\_

Title: \_\_\_\_\_

[CORPORATE SEAL]

Attest: \_\_\_\_\_

Title: \_\_\_\_\_

Address for giving notices:





(If Owner is a corporation, attach evidence of authority to sign. If Owner is a public body, attach evidence of authority to sign and resolution or other documents authorizing execution of Owner-Contractor Agreement.)

CONTRACTOR:



By: \_\_\_\_\_

Title: \_\_\_\_\_

[CORPORATE SEAL]

Attest: \_\_\_\_\_

Title: \_\_\_\_\_

Address for giving notices:

License No.: \_\_\_\_\_  
(Where applicable)

Agent for service or process: \_\_\_\_\_

(If Contractor is a corporation or a partnership, attach evidence of authority to sign.)

## Notice to Proceed

Dated **Click here to enter a date.**

Project:	Owner:	Owner's Contract No.:
Contract:		Engineer's Project No.:
Contractor:		
Contractor's Address: [send Certified Mail, Return Receipt Requested]		

You are notified that the Contract Times under the above contract will commence to run on **Click here to enter a date.** On or before that date, you are to start performing your obligations under the Contract Documents. In accordance with Article 4 of the Agreement, the date of Substantial Completion is **Click here to enter a date.**, and the date of readiness for final payment is **Click here to enter a date.** [(or) the number of days to achieve Substantial Completion is , and the number of days to achieve readiness for final payment is 15.

Before you may start any Work at the Site, Paragraph 2.01.B of the General Conditions provides that you and Owner must each deliver to the other (with copies to Engineer and other identified additional insureds) certificates of insurance which each is required to purchase and maintain in accordance with the Contract Documents.

Contractor:	Owner:
Received by:	Given by:
	Authorized Signature
(Title)	Title
(Date)	Date

Copy to Engineer

# PERFORMANCE BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):



## CONTRACT

Date:

Amount:

Description (Name and Location):

## BOND

Bond Number:

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Performance Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

### CONTRACTOR AS PRINCIPAL

Company:

Signature: \_\_\_\_\_ (Seal)

Name and Title:

(Space is provided below for signatures of additional parties, if required.)

### CONTRACTOR AS PRINCIPAL

Company:

Signature: \_\_\_\_\_ (Seal)

Name and Title:

### SURETY

\_\_\_\_\_  
(Seal)

Surety's Name and Corporate Seal

By:

Signature and Title

(Attach Power of Attorney)

Attest:

Signature and Title

### SURETY

\_\_\_\_\_  
(Seal)

Surety's Name and Corporate Seal

By:

Signature and Title

(Attach Power of Attorney)

Attest:

Signature and Title:

EJCDC No. C-610 (2002 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, and the American Institute of Architects.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner for the performance of the Contract, which is incorporated herein by reference.

2. If Contractor performs the Contract, Surety and Contractor have no obligation under this Bond, except to participate in conferences as provided in Paragraph 3.1.

3. If there is no Owner Default, Surety's obligation under this Bond shall arise after:

3.1. Owner has notified Contractor and Surety, at the addresses described in Paragraph 10 below, that Owner is considering declaring a Contractor Default and has requested and attempted to arrange a conference with Contractor and Surety to be held not later than 15 days after receipt of such notice to discuss methods of performing the Contract. If Owner, Contractor and Surety agree, Contractor shall be allowed a reasonable time to perform the Contract, but such an agreement shall not waive Owner's right, if any, subsequently to declare a Contractor Default; and

3.2. Owner has declared a Contractor Default and formally terminated Contractor's right to complete the Contract. Such Contractor Default shall not be declared earlier than 20 days after Contractor and Surety have received notice as provided in Paragraph 3.1; and

3.3. Owner has agreed to pay the Balance of the Contract Price to:

1. Surety in accordance with the terms of the Contract;
2. Another contractor selected pursuant to Paragraph 4.3 to perform the Contract.

4. When Owner has satisfied the conditions of Paragraph 3, Surety shall promptly and at Surety's expense take one of the following actions:

4.1. Arrange for Contractor, with consent of Owner, to perform and complete the Contract; or

4.2. Undertake to perform and complete the Contract itself, through its agents or through independent contractors; or

4.3. Obtain bids or negotiated proposals from qualified contractors acceptable to Owner for a contract for performance and completion of the Contract, arrange for a contract to be prepared for execution by Owner and Contractor selected with Owner's concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Contract, and pay to Owner the amount of damages as described in Paragraph 6 in excess of the Balance of the Contract Price incurred by Owner resulting from Contractor Default; or

4.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor and with reasonable promptness under the circumstances:

1. After investigation, determine the amount for which it may be liable to Owner and, as soon as practicable after the amount is determined, tender payment therefor to Owner; or
2. Deny liability in whole or in part and notify Owner citing reasons therefor.

5. If Surety does not proceed as provided in Paragraph 4 with reasonable promptness, Surety shall be deemed to be in default on this Bond 15 days after receipt of an additional written notice from Owner to Surety demanding that Surety perform its obligations under this Bond, and Owner shall be entitled to enforce any remedy available to Owner. If Surety proceeds as provided in Paragraph 4.4, and Owner refuses the payment tendered or Surety has denied liability, in whole or in part, without further notice Owner shall be entitled to enforce any remedy available to Owner.

6. After Owner has terminated Contractor's right to complete the Contract, and if Surety elects to act under Paragraph 4.1, 4.2, or 4.3 above, then the responsibilities of Surety to Owner shall not be greater than those of Contractor under the Contract, and the responsibilities of Owner to Surety shall not be greater than those of Owner under the Contract. To a limit of the amount of this Bond, but subject to commitment by Owner of the Balance of the Contract Price to mitigation of costs and damages on the Contract, Surety is obligated without duplication for:

6.1. The responsibilities of Contractor for correction of defective Work and completion of the Contract;

6.2. Additional legal, design professional, and delay costs resulting from Contractor's Default, and resulting from the actions or failure to act of Surety under Paragraph 4; and

6.3. Liquidated damages, or if no liquidated damages are specified in the Contract, actual damages caused by delayed performance or non-performance of Contractor.

7. Surety shall not be liable to Owner or others for obligations of Contractor that are unrelated to the Contract, and the Balance of the Contract Price shall not be reduced or set off on account of any such unrelated obligations. No right of action shall accrue on this Bond to any person or entity other than Owner or its heirs, executors, administrators, or successors.

8. Surety hereby waives notice of any change, including changes of time, to Contract or to related subcontracts, purchase orders, and other obligations.

9. Any proceeding, legal or equitable, under this Bond may be instituted in any court of competent jurisdiction in the location in which the Work or part of the Work is located and shall be instituted within two years after Contractor Default or within two years after Contractor ceased working or within two years after Surety refuses or fails to perform its obligations under this Bond, whichever occurs first. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.

10. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the address shown on the signature page.

11. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory bond and not as a common law bond.

12. Definitions.

12.1. Balance of the Contract Price: The total amount payable by Owner to Contractor under the Contract after all proper adjustments have been made, including allowance to Contractor of any amounts received or to be received by Owner in settlement of insurance or other Claims for damages to which Contractor is entitled, reduced by all valid and proper payments made to or on behalf of Contractor under the Contract.

12.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.

12.3. Contractor Default: Failure of Contractor, which has neither been remedied nor waived, to perform or otherwise to comply with the terms of the Contract.

12.4. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

FOR INFORMATION ONLY – Name, Address and Telephone  
Surety Agency or Broker  
Owner's Representative (engineer or other party)



# PAYMENT BOND

Any singular reference to Contractor, Surety, Owner, or other party shall be considered plural where applicable.

CONTRACTOR (Name and Address):

SURETY (Name and Address of Principal Place of Business):

OWNER (Name and Address):



## CONTRACT

Date:

Amount:

Description (Name and Location):

## BOND

Bond Number:

Date (Not earlier than Contract Date):

Amount:

Modifications to this Bond Form:

Surety and Contractor, intending to be legally bound hereby, subject to the terms printed on the reverse side hereof, do each cause this Payment Bond to be duly executed on its behalf by its authorized officer, agent, or representative.

### CONTRACTOR AS PRINCIPAL

Company:

Signature: \_\_\_\_\_ (Seal)

Name and Title:

(Space is provided below for signatures of additional parties, if required.)

### CONTRACTOR AS PRINCIPAL

Company:

Signature: \_\_\_\_\_ (Seal)

Name and Title:

### SURETY

\_\_\_\_\_  
(Seal)

Surety's Name and Corporate Seal

By:

Signature and Title

(Attach Power of Attorney)

Attest:

Signature and Title

### SURETY

\_\_\_\_\_  
(Seal)

Surety's Name and Corporate Seal

By:

Signature and Title

(Attach Power of Attorney)

Attest:

Signature and Title:

EJCDC No. C-615 (2002 Edition)

Originally prepared through the joint efforts of the Surety Association of America, Engineers Joint Contract Documents Committee, the Associated General Contractors of America, the American Institute of Architects, the American Subcontractors Association, and the Associated Specialty Contractors.

1. Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to Owner to pay for labor, materials, and equipment furnished by Claimants for use in the performance of the Contract, which is incorporated herein by reference.
2. With respect to Owner, this obligation shall be null and void if Contractor:
  - 2.1. Promptly makes payment, directly or indirectly, for all sums due Claimants, and
  - 2.2. Defends, indemnifies, and holds harmless Owner from all claims, demands, liens, or suits alleging non-payment by Contractor by any person or entity who furnished labor, materials, or equipment for use in the performance of the Contract, provided Owner has promptly notified Contractor and Surety (at the addresses described in Paragraph 12) of any claims, demands, liens, or suits and tendered defense of such claims, demands, liens, or suits to Contractor and Surety, and provided there is no Owner Default.
3. With respect to Claimants, this obligation shall be null and void if Contractor promptly makes payment, directly or indirectly, for all sums due.
4. Surety shall have no obligation to Claimants under this Bond until:
  - 4.1. Claimants who are employed by or have a direct contract with Contractor have given notice to Surety (at the addresses described in Paragraph 12) and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and, with substantial accuracy, the amount of the claim.
  - 4.2. Claimants who do not have a direct contract with Contractor:
    1. Have furnished written notice to Contractor and sent a copy, or notice thereof, to Owner, within 90 days after having last performed labor or last furnished materials or equipment included in the claim stating, with substantial accuracy, the amount of the claim and the name of the party to whom the materials or equipment were furnished or supplied, or for whom the labor was done or performed; and
    2. Have either received a rejection in whole or in part from Contractor, or not received within 30 days of furnishing the above notice any communication from Contractor by which Contractor had indicated the claim will be paid directly or indirectly; and
    3. Not having been paid within the above 30 days, have sent a written notice to Surety and sent a copy, or notice thereof, to Owner, stating that a claim is being made under this Bond and enclosing a copy of the previous written notice furnished to Contractor.
5. If a notice by a Claimant required by Paragraph 4 is provided by Owner to Contractor or to Surety, that is sufficient compliance.
6. When a Claimant has satisfied the conditions of Paragraph 4, the Surety shall promptly and at Surety's expense take the following actions:
  - 6.1. Send an answer to that Claimant, with a copy to Owner, within 45 days after receipt of the claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed.
  - 6.2. Pay or arrange for payment of any undisputed amounts.
7. Surety's total obligation shall not exceed the amount of this Bond, and the amount of this Bond shall be credited for any payments made in good faith by Surety.
8. Amounts owed by Owner to Contractor under the Contract shall be used for the performance of the Contract and to satisfy claims, if any, under any performance bond. By Contractor furnishing and Owner accepting this Bond, they agree that all funds earned by Contractor in the performance of the Contract are dedicated to satisfy obligations of Contractor and Surety under this Bond, subject to Owner's priority to use the funds for the completion of the Work.
9. Surety shall not be liable to Owner, Claimants, or others for obligations of Contractor that are unrelated to the Contract. Owner shall not be liable for payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligations to make payments to, give notices on behalf of, or otherwise have obligations to Claimants under this Bond.
10. Surety hereby waives notice of any change, including changes of time, to the Contract or to related Subcontracts, purchase orders and other obligations.
11. No suit or action shall be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the location in which the Work or part of the Work is located or after the expiration of one year from the date (1) on which the Claimant gave the notice required by Paragraph 4.1 or Paragraph 4.2.3, or (2) on which the last labor or service was performed by anyone or the last materials or equipment were furnished by anyone under the Construction Contract, whichever of (1) or (2) first occurs. If the provisions of this paragraph are void or prohibited by law, the minimum period of limitation available to sureties as a defense in the jurisdiction of the suit shall be applicable.
12. Notice to Surety, Owner, or Contractor shall be mailed or delivered to the addresses shown on the signature page. Actual receipt of notice by Surety, Owner, or Contractor, however accomplished, shall be sufficient compliance as of the date received at the address shown on the signature page.
13. When this Bond has been furnished to comply with a statutory requirement in the location where the Contract was to be performed, any provision in this Bond conflicting with said statutory requirement shall be deemed deleted herefrom and provisions conforming to such statutory requirement shall be deemed incorporated herein. The intent is that this Bond shall be construed as a statutory Bond and not as a common law bond.
14. Upon request of any person or entity appearing to be a potential beneficiary of this Bond, Contractor shall promptly furnish a copy of this Bond or shall permit a copy to be made.
15. DEFINITIONS
  - 15.1. Claimant: An individual or entity having a direct contract with Contractor, or with a first-tier subcontractor of Contractor, to furnish labor, materials, or equipment for use in the performance of the Contract. The intent of this Bond shall be to include without limitation in the terms "labor, materials or equipment" that part of water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Contract, architectural and engineering services required for performance of the Work of Contractor and Contractor's Subcontractors, and all other items for which a mechanic's lien may be asserted in the jurisdiction where the labor, materials, or equipment were furnished.
  - 15.2. Contract: The agreement between Owner and Contractor identified on the signature page, including all Contract Documents and changes thereto.
  - 15.3. Owner Default: Failure of Owner, which has neither been remedied nor waived, to pay Contractor as required by the Contract or to perform and complete or comply with the other terms thereof.

**FOR INFORMATION ONLY – Name, Address and Telephone  
Surety Agency or Broker:  
Owner's Representative (engineer or other party):**

# Contractor's Application For Payment No. \_\_\_\_\_

	Application Period:	Application Date:
To (Owner):	From (Contractor):	Via (Engineer)
Project:	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

## APPLICATION FOR PAYMENT

### Change Order Summary

Approved Change Orders		
Number	Additions	Deductions
TOTALS		
NET CHANGE BY CHANGE ORDERS		

1. ORIGINAL CONTRACT PRICE .....	\$	
2. Net change by Change Orders .....	\$	
3. CURRENT CONTRACT PRICE (Line 1 ± 2) .....	\$	
4. TOTAL COMPLETED AND STORED TO DATE (Column F on Progress Estimate) .....	\$	
5. RETAINAGE:		
a. _____ % x \$ _____ Work Completed .....	\$	
b. _____ % x \$ _____ Stored Material .....	\$	
c. Total Retainage (Line 5a + Line 5b) .....	\$	
6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5c) .....	\$	
7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application) .....	\$	
8. AMOUNT DUE THIS APPLICATION .....	\$	
9. BALANCE TO FINISH, PLUS RETAINAGE (Column G on Progress Estimate + Line 5 above) .....	\$	

## CONTRACTOR'S CERTIFICATION

The undersigned Contractor certifies that: (1) all previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with Work covered by prior Applications for Payment; (2) title of all Work, materials and equipment incorporated in said Work or otherwise listed in or covered by this Application for Payment will pass to Owner at time of payment free and clear of all Liens, security interests and encumbrances (except such as are covered by a Bond acceptable to Owner indemnifying Owner against any such Liens, security interest or encumbrances); and (3) all Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

By:	Date:
-----	-------

Payment of:	\$ _____	(Line 8 or other - attach explanation of other amount)
is recommended by:	_____	_____ (Date)
	(Engineer)	
Payment of:	\$ _____	(Line 8 or other - attach explanation of other amount)
is approved by:	_____	_____ (Date)
	(Owner)	
Approved by:	_____	_____ (Date)
	Funding Agency (if applicable)	

## Progress Estimate

## Contractor's Application

For (contract):						Application Number:		
Application Period:						Application Date:		
A		B	Work Completed		E	F		G
Item		Scheduled Value	C	D	Materials Presently Stored (not in C or D)	Total Completed and Stored to Date (C + D + E)	% (F) B	Balance to Finish (B - F)
Specification Section No.	Description		From Previous Application (C + D)	This Period				
	Totals							

## Progress Estimate

## Contractor's Application

For (contract):						Application Number:				
Application Period:						Application Date:				
A				B	C	D	E	F		G
Item		Bid Quantity	Unit Price	Bid Value	Estimated Quantity Installed	Value	Materials Presently Stored (not in C)	Total Completed and Stored to Date (D + E)	% (F) B	Balance to Finish (B - F)
Bid Item No.	Description									
	Totals									

## Stored Material Summary

## Contractor's Application

For (contract):					Application Number:				
Application Period:					Application Date:				
A	B	C	D		E		F		G
Invoice No.	Shop Drawing Transmittal No.	Materials Description	Stored Previously		Stored this Month		Incorporated in Work		Materials Remaining in Storage (\$) (D + E - F)
			Date (Month/Year)	Amount (\$)	Amount (\$)	Subtotal	Date (Month/Year)	Amount (\$)	
		Totals							

# Certificate of Substantial Completion

Project:	Owner:	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

**This [tentative] [definitive] Certificate of Substantial Completion applies to:**

- ☐ All Work under the Contract Documents: ☐ The following specified portions:

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\_\_\_\_\_  
Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Project or portion thereof designated above is hereby declared and is also the date of commencement of applicable warranties required by the Contract Documents, except as stated below.

A [tentative] [revised tentative] [definitive] list of items to be completed or corrected, is attached hereto. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

**The responsibilities between OWNER and CONTRACTOR for security, operation, safety, maintenance, heat, utilities, insurance and warranties shall be as provided in the Contract Documents except as amended as follows:**

- ☐ Amended Responsibilities ☐ Not Amended

Owner's Amended Responsibilities:

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Contractor's Amended Responsibilities:

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The following documents are attached to and made part of this Certificate:

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This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract Documents.

\_\_\_\_\_  
Executed by Engineer

\_\_\_\_\_  
Date

\_\_\_\_\_  
Accepted by Contractor

\_\_\_\_\_  
Date

\_\_\_\_\_  
Accepted by Owner

\_\_\_\_\_  
Date

**SECTION 00630**  
**Maintenance Warranties**

- (a) The Contractor shall fully warranty all work for at least one (1) full year from Substantial Completion of the Project, regardless of the length of the manufacturers' or installers' warranties.
- (b) In addition to any other warranties that are required, the Contractor shall make all necessary repairs and replacements to remedy any and all defects, breaks, or failures of the Work occurring with one (1) year following the date of Substantial Completion by the OWNER due to faulty or inadequate materials or workmanship. Such repairs and replacements shall conform to the Contract Specifications under which the Contractor originally performed the work.
- (c) In the event of a dispute regarding any portion of the Work, the Contractor shall nonetheless provide any warranty service, repairs or replacements as described in (a) and (b) above, for that portion of the Work that is not in dispute. In the event that a dispute delays Acceptance of the Work, the warranty for portions of the Work not in dispute shall run from the date of Substantial Completion of the remaining portions of the Work.
- (d) The Contractor shall also repair any damage or remedy any disturbance to other publicly owned property or improvements thereon if cause by the Contractor's work and if the damage or remedy occurs during the warranty period.
- (e) If the Contractor performs any warranty work, the warranty work also shall have a one (1) year warranty period from the date of its completion and acceptance by the Owner.
- (f) The Owner will provide the Contractor with written Notice of the need to perform warranty work unless it is determined that an emergency exists, that delay would cause serious additional loss or damage, or if any delay in performing the work might cause injury to any member of the public. If the Contractor, after written Notice, fails within ten days to comply with the Owner's request, the Owner has the right to perform the warranty work either by hiring another Contractor or by using its own forces. In that event, the Contractor and its Surety shall be liable to the Owner for the cost of the work performed and any additional damage suffered by the Owner.
- (g) The Contractor shall provide a bond during the one-year warranty period to guarantee the Contractor's performance of the warranty work. The Contractor shall provide to the Owner a bond in the amount of 10% of the final Contract Amount in one of the following ways:

  - 1. Continuance of the Contract performance Bond and the Payment Bond.



2. Any new performance Bond and the Payment Bond, acceptable to the Owner, which covers the Contractor's warranty obligations imposed by the Contract Documents.
  3. Cash deposit to the OWNER. Proof of the deposit shall be a receipt from the OWNER.
  4. Posting of a separate Warranty Bond.
  5. Other arrangements proposed by the Contractor that the Owner finds acceptable.
- (h)** The successful performance of this Contract will provide a benefit to the citizens, ratepayers, or taxpayers. Therefore, satisfactory completion of the Project by the Contractor is of a paramount importance. The Contractor agrees that by accepting this Contract it is required to perform the Contract in accordance with the Contract Documents and cannot contend that its performance was excused by any action of the Owner, except to the extent that the Contract terms have been modified by a written Change Order executed by both parties.
- (i)** The Owner is entitled to insist upon completion of the Contract in the manner and to the extent required by the Contract Documents. Therefore, any measurement, estimate, or certificate made by the Owner that is incorrect may be corrected by the Owner at any time, regardless of whether that occurs before or after the acceptance of the Project. Similarly, if work, equipment, parts, products or materials do not conform to what is required by the Contract Documents, the Owner may require that the work be redone and that materials, parts, products, and equipment be replace, regardless of prior approval by any agent or employee of the Owner.
- (j)** Acceptance of the Work by the Owner will not preclude the Owner from:
1. Later insisting that the Work be performed in accordance with the Contract Documents.
  2. Recovering damages for breach of contract or pursuing any other remedies that the law may provide.
  3. Any other remedy for breach of contract permitted by law.
- (k)** No action whatsoever, nor any verbal or written statement whatsoever, made by any employee or agent of the Owner, will operate as a waiver or as an estoppels, or otherwise preclude the Owner from insisting upon its rights to performance of the Contract in accordance with the Contract Documents.

## MAINTENANCE/WARRANTY BOND

KNOW ALL MEN BY THESE PRESENTS that we, \_\_\_\_\_, as Principal, and \_\_\_\_\_, a corporation organized and existing under the laws of the State of \_\_\_\_\_, and duly authorized to transact a surety business in the State of \_\_\_\_\_, as surety, are held and firmly bound unto the \_\_\_\_\_, a municipal corporation of the State of \_\_\_\_\_, in the penal sum of \$ \_\_\_\_\_ Dollars (\$ \_\_\_\_\_), (the amount equal to ten percent (10%) of the final contract price), lawful money of the United States of America, for the payment whereof well and truly to be made, we and each of us, jointly and severally, bind ourselves, our and each of our heirs, executors, administrators successors and assign, firmly by these presents.

THE CONDITION OF THIS BOND IS SUCH:

THAT WHEREAS the Principal did on the (\_\_\_\_\_), enter into Contract with \_\_\_\_\_ for \_\_\_\_\_, that was completed on (\_\_\_\_\_), which requires a one-year Maintenance and Warranty.

NOW THEREFORE, if the Principal herein shall faithfully and truly observe the terms, provisions, conditions, stipulations, directions, and requirements of said contract and shall in all respects, whether the same be enumerated herein or not, faithfully comply with the same and shall assume the defense of indemnify and save harmless the owner, its officers, agents, and employees from all claims, liabilities, loss, damage or injury which may have been suffered or claimed to have been suffered to persons or property directly or indirectly resulting from or arising out of the operations or conduct of said Principal or any subcontractor in the performance of the work under said contract and shall indemnify and make whole the owner for any injury or damage to any street, highway, avenue, road, watermain, tank, pump, appurtenance, or any part thereof, resulting from the operations or conduct of said Principal or any subcontractor in connection with performance or conduct of the work under said contract, and shall in all respects faithfully keep and observe all of said terms, provision, conditions, stipulations, directions, and requirements, then this obligation is void, otherwise, it shall remain in full force and effect.

WITNESS our hand and seals this \_\_\_\_\_ day of \_\_\_\_\_, 20\_\_\_\_

**Contractor**

\_\_\_\_\_  
**BY:**

**TITLE:** \_\_\_\_\_

**Surety**

**By:** \_\_\_\_\_

**Attorney-In-Fact**

**APPROVED**

\_\_\_\_\_  
**Owner**

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## GENERAL CONDITIONS

### ARTICLE 1 - DEFINITIONS AND TERMINOLOGY

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#### 1.01 *Defined Terms*

A. Wherever used in the Bidding Requirements or Contract Documents and printed with initial capital letters, the terms listed below will have the meanings indicated which are applicable to both the singular and plural thereof. In addition to terms specifically defined, terms with initial capital letters in the Contract Documents include references to identified articles and paragraphs, and the titles of other documents or forms.

1. *Addenda*--Written or graphic instruments issued prior to the opening of Bids which clarify, correct, or change the Bidding Requirements or the proposed Contract Documents.

2. *Agreement*--The written instrument which is evidence of the agreement between Owner and Contractor covering the Work.

3. *Application for Payment*--The form acceptable to Engineer which is to be used by Contractor during the course of the Work in requesting progress or final payments and which is to be accompanied by such supporting documentation as is required by the Contract Documents.

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.

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

6. *Bidder*--The individual or entity who submits a Bid directly to Owner.

7. *Bidding Documents*--The Bidding Requirements and the proposed Contract Documents (including all Addenda).

8. *Bidding Requirements*--The Advertisement or Invitation to Bid, Instructions to Bidders, bid security of acceptable form, if any, and the Bid Form with any supplements.

9. *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.

10. *Claim*--A demand or assertion by Owner or Contractor seeking an adjustment of Contract Price or Contract Times, or both, or other relief with respect to the terms of the Contract. A demand for money or services by a third party is not a Claim.

11. *Contract*--The entire and integrated written agreement between the Owner and Contractor concerning the Work. The Contract supersedes prior negotiations, representations, or agreements, whether written or oral.

12. *Contract Documents*-- Those items so designated in the Agreement. Only printed or hard copies of the items listed in the Agreement are Contract Documents. Approved Shop Drawings, other Contractor's submittals, and the reports and drawings of subsurface and physical conditions are not Contract Documents.

13. *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 11.03 in the case of Unit Price Work).

14. *Contract Times*--The number of days or the dates stated in the Agreement to: (i) achieve Milestones, if any, (ii) achieve Substantial Completion; and (iii) complete the Work so that it is ready for final payment as evidenced by Engineer's written recommendation of final payment.

15. *Contractor*--The individual or entity with whom Owner has entered into the Agreement.

16. *Cost of the Work*--See Paragraph 11.01.A for definition.

17. *Drawings*--That part of the Contract Documents prepared or approved by Engineer which graphically shows the scope, extent, and character of the Work to be performed by Contractor. Shop Drawings and other Contractor submittals are not Drawings as so defined.

18. *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.

19. *Engineer*--The individual or entity named as such in the Agreement.

20. *Field Order*--A written order issued by Engineer which requires minor changes in the Work but which does not involve a change in the Contract Price or the Contract Times.

21. *General Requirements*--Sections of Division 1 of the Specifications. The General Requirements pertain to all sections of the Specifications.

22. *Hazardous Environmental Condition*--The presence at the Site of Asbestos, PCBs, Petroleum, Hazardous Waste, or Radioactive Material in such quantities or circumstances that may present a substantial danger to persons or property exposed thereto in connection with the Work.

23. *Hazardous Waste*--The term Hazardous Waste shall have the meaning provided in Section 1004 of the Solid Waste Disposal Act (42 USC Section 6903) as amended from time to time.

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

25. *Liens*--Charges, security interests, or encumbrances upon Project funds, real property, or personal property.

26. *Milestone*--A principal event specified in the Contract Documents relating to an intermediate completion date or time prior to Substantial Completion of all the Work.

27. *Notice of Award*--The written notice by Owner to the Successful Bidder stating that upon timely compliance by the Successful Bidder with the conditions precedent listed therein, Owner will sign and deliver the Agreement.

28. *Notice to Proceed*--A written notice given by Owner to Contractor fixing the date on which the Contract Times will commence to run and on which Contractor shall start to perform the Work under the Contract Documents.

29. *Owner*--The individual or entity with whom Contractor has entered into the Agreement and for whom the Work is to be performed.

30. *PCBs*--Polychlorinated biphenyls.

31. *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, kerosene, and oil mixed with other non-Hazardous Waste and crude oils.

32. *Progress Schedule*--A schedule, prepared and maintained by Contractor, describing the sequence and duration of the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.

33. *Project*--The total construction of which the Work to be performed under the Contract Documents may be the whole, or a part.

34. *Project Manual*--The bound documentary information prepared for bidding and constructing the Work. A listing of the contents of the Project Manual, which may be bound in one or more volumes, is contained in the table(s) of contents.

35. *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.

36. *Related Entity* -- An officer, director, partner, employee, agent, consultant, or subcontractor.

37. *Resident Project Representative*--The authorized representative of Engineer who may be assigned to the Site or any part thereof.

38. *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.

39. *Schedule of Submittals*--A schedule, prepared and maintained by Contractor, of required submittals and the time requirements to support scheduled performance of related construction activities.

40. *Schedule of Values*--A schedule, prepared and maintained by Contractor, allocating portions of the Contract Price to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

41. *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.

42. *Site*--Lands or areas indicated in the Contract Documents as being furnished by Owner upon which the Work is to be performed, including rights-of-way and easements for access thereto, and such other lands furnished by Owner which are designated for the use of Contractor.

43. *Specifications*--That part of the Contract Documents consisting of written requirements for materials, equipment, systems, standards and workmanship as applied to the Work, and certain

administrative requirements and procedural matters applicable thereto.

44. *Subcontractor*--An individual or entity having a direct contract with Contractor or with any other Subcontractor for the performance of a part of the Work at the Site.

45. *Substantial Completion*--The time at which the Work (or a specified part thereof) has progressed to the point where, in the opinion of Engineer, the Work (or a specified part thereof) is sufficiently complete, in accordance with the Contract Documents, so that the Work (or a specified part thereof) can be utilized for the purposes for which it is intended. The terms "substantially complete" and "substantially completed" as applied to all or part of the Work refer to Substantial Completion thereof.

46. *Successful Bidder*--The Bidder submitting a responsive Bid to whom Owner makes an award.

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

48. *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.

49. *Underground Facilities*--All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments, and any encasements containing such facilities, including those that convey electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, storm water, other liquids or chemicals, or traffic or other control systems.

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

51. *Work*--The entire construction or the various separately identifiable parts thereof required to be provided under the Contract Documents. Work includes and is the result of performing or providing all labor, services, and documentation necessary to produce such construction, and furnishing, installing, and incorporating all materials and equipment into such construction, all as required by the Contract Documents.

52. *Work Change Directive*--A written statement 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 subsurface or physical conditions under which the Work is to be performed or to emergencies. A Work Change Directive will not change the Contract Price or the Contract Times

but is evidence that the parties expect that the change ordered 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.

## 1.02 Terminology

A. The following words or terms are not defined but, when used in the Bidding Requirements or Contract Documents, have the following meaning.

### B. Intent of Certain Terms or Adjectives

1. The Contract Documents include the terms "as allowed," "as approved," "as ordered", "as directed" or terms of like effect or import to authorize an exercise of professional judgment by Engineer. In addition, the adjectives "reasonable," "suitable," "acceptable," "proper," "satisfactory," or adjectives of like effect or import are used to describe an action or determination of Engineer as to the Work. It is intended that such exercise of professional judgment, action or determination will be solely to evaluate, in general, the Work for compliance with the requirements of and information in the Contract Documents and conformance with the design concept of the completed Project as a functioning whole as shown or indicated in the Contract Documents (unless there is a specific statement indicating otherwise). The use of any such term or adjective is not intended to and shall not be effective to assign to Engineer any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility contrary to the provisions of Paragraph 9.09 or any other provision of the Contract Documents.

### C. Day

1. The word "day" means a calendar day of 24 hours measured from midnight to the next midnight.

### D. Defective

1. The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it:

a. does not conform to the Contract Documents, or

b. does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents, or

c. 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 14.04 or 14.05).



#### *E. Furnish, Install, Perform, Provide*

1. The word “furnish,” when used in connection with services, materials, or equipment, shall mean to supply and deliver said services, materials, or equipment to the Site (or some other specified location) ready for use or installation and in usable or operable condition.

2. The word “install,” when used in connection with services, materials, or equipment, shall mean to put into use or place in final position said services, materials, or equipment complete and ready for intended use.

3. The words “perform” or “provide,” when used in connection with services, materials, or equipment, shall mean to furnish and install said services, materials, or equipment complete and ready for intended use.

4. When “furnish,” “install,” “perform,” or “provide” is not used in connection with services, materials, or equipment in a context clearly requiring an obligation of Contractor, “provide” is implied.

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

## ARTICLE 2 - PRELIMINARY MATTERS

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### *2.01 Delivery of Bonds and Evidence of Insurance*

A. When Contractor delivers the executed counterparts of the Agreement to Owner, Contractor shall also deliver to Owner such bonds as Contractor may be required to furnish.

B. *Evidence of Insurance:* 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 Article 5.

### *2.02 Copies of Documents*

A. Owner shall furnish to Contractor up to ten printed or hard copies of the Drawings and Project Manual. Additional copies will be furnished upon request at the cost of reproduction.

### *2.03 Commencement of Contract Times; Notice to Proceed*

A. 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 30 days after the Effective Date of the Agreement. In no event will the Contract Times commence to run later than the sixtieth day after the day of Bid opening or the thirtieth day after the Effective Date of the Agreement, whichever date is earlier.

### *2.04 Starting the Work*

A. Contractor shall start to perform the Work on the date when the Contract Times commence to run. No Work shall be done at the Site prior to the date on which the Contract Times commence to run.

### *2.05 Before Starting Construction*

A. *Preliminary Schedules:* Within 10 days after the Effective Date of the Agreement (unless otherwise specified in the General Requirements), Contractor shall submit to Engineer for timely review:

1. a preliminary Progress Schedule; indicating the times (numbers of days or dates) for starting and completing the various stages of the Work, including any Milestones specified in the Contract Documents;

2. a preliminary Schedule of Submittals; and

3. a preliminary Schedule of Values for all of the Work which includes quantities and prices of items which when added together equal the Contract Price and subdivides the Work into component parts in sufficient detail to serve as the basis for progress payments during performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.

### *2.06 Preconstruction Conference*

A. Before any Work at the Site is started, a conference attended by Owner, 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 2.05.A, procedures for handling Shop Drawings and other submittals, processing Applications for Payment, and maintaining required records.

### *2.07 Initial Acceptance of Schedules*

A. At least 10 days before submission of the first Application for Payment a conference attended by Contractor, Engineer, and others as appropriate will be held to review for acceptability to Engineer as provided below the schedules submitted in accordance with Paragraph 2.05.A. Contractor shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No progress payment shall be made to Contractor until acceptable schedules are submitted to Engineer.

1. The Progress Schedule will be acceptable to Engineer if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Engineer responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work nor interfere with or relieve Contractor from Contractor's full responsibility therefor.

2. Contractor's Schedule of Submittals will be acceptable to Engineer if it provides a workable arrangement for reviewing and processing the required submittals.

3. Contractor's Schedule of Values will be acceptable to Engineer as to form and substance if it provides a reasonable allocation of the Contract Price to component parts of the Work.

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

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#### 3.01 *Intent*

A. The Contract Documents are complementary; what is required by one is as binding as if required by all.

B. It is the intent of the Contract Documents to describe a functionally complete Project (or part thereof) to be constructed in accordance with the Contract Documents. Any labor, documentation, services, 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 provided whether or not specifically called for at no additional cost to Owner.

C. Clarifications and interpretations of the Contract Documents shall be issued by Engineer as provided in Article 9.

#### 3.02 *Reference Standards*

A. Standards, Specifications, Codes, Laws, and Regulations

1. Reference to standards, specifications, manuals, or codes of any technical society, organization, or association, or to Laws or Regulations, whether such reference be specific or by implication, shall mean the 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.

2. No provision of any such standard, specification, manual or code, or any instruction of a Supplier shall be effective to change the duties or

responsibilities of Owner, Contractor, or Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents. No such provision or instruction shall be effective to assign to Owner, or Engineer, or any of, their Related Entities, any duty or authority to supervise or direct the performance of the Work or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract Documents.

#### 3.03 *Reporting and Resolving Discrepancies*

##### A. Reporting Discrepancies

1. *Contractor's Review of Contract Documents Before Starting Work:* Before undertaking each part of the Work, Contractor shall carefully study and compare the Contract Documents and check and verify pertinent figures therein and all applicable field measurements. Contractor 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.

2. *Contractor's Review of Contract Documents During Performance of Work:* If, during the performance of the Work, Contractor discovers any conflict, error, ambiguity, or discrepancy within the Contract Documents or between the Contract Documents and any provision of any Law or Regulation applicable to the performance of the Work or of any standard, specification, manual or code, or of any instruction of any Supplier, Contractor shall promptly report it to Engineer in writing. Contractor shall not proceed with the Work affected thereby (except in an emergency as required by Paragraph 6.16.A) until an amendment or supplement to the Contract Documents has been issued by one of the methods indicated in Paragraph 3.04.

3. 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 reasonably should have known thereof.

##### B. Resolving Discrepancies

1. Except as may be otherwise specifically stated in the Contract Documents, 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:

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

b. the provisions of any Laws or Regulations applicable to the performance of the Work

(unless such an interpretation of the provisions of the Contract Documents would result in violation of such Law or Regulation).

### 3.04 *Amending and Supplementing Contract Documents*

A. The Contract Documents may be amended to provide for additions, deletions, and revisions in the Work or to modify the terms and conditions thereof by either a Change Order or a Work Change Directive.

B. The requirements of the Contract Documents may be supplemented, and minor variations and deviations in the Work may be authorized, by one or more of the following ways:

1. A Field Order;

2. Engineer's approval of a Shop Drawing or Sample; (Subject to the provisions of Paragraph 6.17.D.3); or

3. Engineer's written interpretation or clarification.

### 3.05 *Reuse of Documents*

A. Contractor and any Subcontractor or Supplier or other individual or entity performing or furnishing all of the Work under a direct or indirect contract with Contractor, shall not:

1. 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 consultants, including electronic media editions; or

2. reuse any of such Drawings, Specifications, other documents, or copies thereof on extensions of the Project or any other project without written consent of Owner and Engineer and specific written verification or adaption by Engineer.

B. The prohibition of this Paragraph 3.05 will survive final payment, or termination of the Contract. Nothing herein shall preclude Contractor from retaining copies of the Contract Documents for record purposes.

### 3.06 *Electronic Data*

A. Copies of data furnished by Owner or Engineer to Contractor or Contractor to Owner or Engineer that may be relied upon are limited to the printed copies (also known as hard copies). Files in electronic media format of text, data, graphics, or other types are furnished only for the convenience of the receiving party. Any conclusion or information obtained or derived from such electronic files will be at the user's

sole risk. If there is a discrepancy between the electronic files and the hard copies, the hard copies govern.

B. Because data stored in electronic media format can deteriorate or be modified inadvertently or otherwise without authorization of the data's creator, the party receiving electronic files agrees that it will perform acceptance tests or procedures within 60 days, after which the receiving party shall be deemed to have accepted the data thus transferred. Any errors detected within the 60-day acceptance period will be corrected by the transferring party..

C. When transferring documents in electronic media format, the transferring party makes no representations as to long term compatibility, usability, or readability of documents resulting from the use of software application packages, operating systems, or computer hardware differing from those used by the data's creator.

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

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### 4.01 *Availability of Lands*

A. Owner shall furnish the Site. Owner shall notify Contractor of any encumbrances or restrictions not of general application but specifically related to use of the Site with which Contractor must comply in performing the Work. Owner will obtain in a timely manner and pay for easements for permanent structures or permanent changes in existing facilities. If Contractor and Owner are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, as a result of any delay in Owner's furnishing the Site or a part thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

B. Upon reasonable written request, Owner shall furnish Contractor with a current 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 or construction lien against such lands in accordance with applicable Laws and Regulations.

C. Contractor shall provide for all additional lands and access thereto that may be required for temporary construction facilities or storage of materials and equipment.

#### 4.02 *Subsurface and Physical Conditions*

A. No reports of explorations or tests of subsurface conditions at or contiguous to the Site are known to the Owner or Engineer.

#### 4.03 *Differing Subsurface or Physical Conditions*

A. *Notice:* If Contractor believes that any subsurface or physical condition at or contiguous to the Site that is uncovered or revealed either:

1. is of such a nature as to establish that any “technical data” on which Contractor is entitled to rely as provided in Paragraph 4.02 is materially inaccurate; or

2. is of such a nature as to require a change in the Contract Documents; or

3. differs materially from that shown or indicated in the Contract Documents; or

4. is of an unusual nature, and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents;

then Contractor shall, promptly after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency as required by Paragraph 6.16.A), notify Owner and Engineer in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except as aforesaid) until receipt of written order to do so.

B. *Engineer’s Review:* After receipt of written notice as required by Paragraph 4.03.A, Engineer will promptly review the pertinent condition, determine the necessity of Owner’s obtaining additional exploration or tests with respect thereto, and advise Owner in writing (with a copy to Contractor) of Engineer’s findings and conclusions.

#### C. Possible Price and Times Adjustments

1. The Contract Price or the Contract Times, or both, will be equitably adjusted to the extent that the existence of such differing subsurface or physical condition causes an increase or decrease in Contractor’s cost of, or time required for, performance of the Work; subject, however, to the following:

a. such condition must meet any one or more of the categories described in Paragraph 4.03.A; and

b. with respect to Work that is paid for on a Unit Price Basis, any adjustment in Contract Price will be subject to the provisions of Paragraphs 9.07 and 11.03.

2. Contractor shall not be entitled to any adjustment in the Contract Price or Contract Times if:

a. Contractor knew of the existence of such conditions at the time Contractor made a final commitment to Owner with respect to Contract Price and Contract Times by the submission of a Bid or becoming bound under a negotiated contract; or

b. the existence of such condition could reasonably have been discovered or revealed as a result of any examination, investigation, exploration, test, or study of the Site and contiguous areas required by the Bidding Requirements or Contract Documents to be conducted by or for Contractor prior to Contractor’s making such final commitment; or

c. Contractor failed to give the written notice as required by Paragraph 4.03.A.

3. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times, or both, a Claim may be made therefor as provided in Paragraph 10.05. However, Owner and Engineer, and any of their Related Entities shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

#### 4.04 *Underground Facilities*

A. *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, including Owner, or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

1. Owner and Engineer shall not be responsible for the accuracy or completeness of any such information or data; and

2. the cost of all of the following will be included in the Contract Price, and Contractor shall have full responsibility for:

- a. reviewing and checking all such information and data,
- b. locating all Underground Facilities shown or indicated in the Contract Documents,
- c. coordination of the Work with the owners of such Underground Facilities, including Owner, during construction, and
- d. the safety and protection of all such Underground Facilities and repairing any damage thereto resulting from the Work.

*B. Not Shown or Indicated*

1. If an Underground Facility is uncovered or revealed at or contiguous to the Site which was not shown or indicated, or not shown or indicated with reasonable accuracy 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 6.16.A), identify the owner of such Underground Facility and give written notice 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 consequences of the existence or location of the Underground Facility. During such time, Contractor shall be responsible for the safety and protection of such Underground Facility.

2. If Engineer concludes that a change in the Contract Documents is required, a Work Change Directive or a Change Order will be issued to reflect and document such consequences. An equitable adjustment shall be made in the Contract Price or Contract Times, or both, to the extent that they are attributable to the existence or location of any Underground Facility that was not shown or indicated or not shown or indicated with reasonable accuracy 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 on the amount or extent, if any, of any such adjustment in Contract Price or Contract Times, Owner or Contractor may make a Claim therefor as provided in Paragraph 10.05.

*4.05 Reference Points*

A. Owner shall provide engineering surveys to establish reference points for construction which in Engineer's judgment 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 property monuments, and shall make no changes or relocations without the prior written approval of Owner. Contractor shall report to Engineer whenever any reference point or property monument 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 or property monuments by professionally qualified personnel.

*4.06 Hazardous Environmental Condition at Site*

A. No reports on drawings related to Hazardous Environmental Conditions are known to Owner or Engineer.

B. Contractor shall not be responsible for any Hazardous Environmental Condition 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. Contractor shall be responsible for a Hazardous Environmental Condition created with any materials brought to the Site by Contractor, Subcontractors, Suppliers, or anyone else for whom Contractor is responsible.

C. If Contractor encounters a Hazardous Environmental Condition or if Contractor or anyone for whom Contractor is responsible creates a Hazardous Environmental Condition, Contractor shall immediately: (i) secure or otherwise isolate such condition; (ii) stop all Work in connection with such condition and in any area affected thereby (except in an emergency as required by Paragraph 6.16.A); and (iii) notify Owner and Engineer (and promptly 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 condition or take corrective action, if any.

D. Contractor shall not be required to resume Work in connection with such condition or in any affected area until after Owner has obtained any required permits related thereto and delivered to Contractor 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 on the amount or extent, if any, of any adjustment in Contract Price or Contract Times, or both, as a result of such Work stoppage or such special conditions under which Work is agreed to be resumed by Contractor, either party may make a Claim therefor as provided in Paragraph 10.05.

E. If after receipt of such 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 the portion of the Work that is in the

area affected by such condition to be deleted from the Work. If Owner and Contractor cannot agree as to entitlement to or on the amount or extent, if any, of an adjustment 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 Paragraph 10.05. Owner may have such deleted portion of the Work performed by Owner's own forces or others in accordance with Article 7.

F. To the fullest extent permitted by Laws and Regulations, Owner shall indemnify and hold harmless Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition, provided that such Hazardous Environmental Condition: (i) was not shown or indicated in the Drawings or Specifications or identified in the Contract Documents to be included within the scope of the Work, and (ii) was not created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06. G shall obligate Owner to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

G. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants, and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to a Hazardous Environmental Condition created by Contractor or by anyone for whom Contractor is responsible. Nothing in this Paragraph 4.06.H shall obligate Contractor to indemnify any individual or entity from and against the consequences of that individual's or entity's own negligence.

H. The provisions of Paragraphs 4.02, 4.03, and 4.04 do not apply to a Hazardous Environmental Condition uncovered or revealed at the Site.

## ARTICLE 5 - BONDS AND INSURANCE

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### 5.01 *Performance, Payment, and Other Bonds*

A. Contractor shall furnish performance and payment bonds, each in an amount at least equal to the Contract Price as security for the faithful performance and payment of all of Contractor's obligations under the Contract Documents. These bonds shall remain in effect

until one year after the date when final payment becomes due or until completion of the correction period specified in Paragraph 13.07, whichever is later, except as provided otherwise by Laws or Regulations or by the Contract Documents. Contractor shall also furnish such other bonds as are required by the Contract Documents.

B. All bonds shall be in the form prescribed by the Contract Documents except as provided otherwise by Laws or Regulations, and shall be executed by such sureties 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 Financial Management Service, Surety Bond Branch, U.S. Department of the Treasury. All bonds signed by an agent must be accompanied by a certified copy of the agent's authority to act.

C. 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 Paragraph 5.01.B, Contractor shall promptly notify Owner and Engineer and shall, within 20 days after the event giving rise to such notification, provide another bond and surety, both of which shall comply with the requirements of Paragraphs 5.01.B and 5.02.

### 5.02 *Licensed Sureties and Insurers*

A. 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.

### 5.03 *Certificates of Insurance*

A. Contractor shall deliver to Owner, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Owner or any other additional insured) which Contractor is required to purchase and maintain.

B. Owner shall deliver to Contractor, with copies to each additional insured identified in the Supplementary Conditions, certificates of insurance (and other evidence of insurance requested by Contractor or any other additional insured) which Owner is required to purchase and maintain.

C. Failure of Owner to demand such certificates or other evidence of full compliance with these insurance requirements or failure of Owner to

identify a deficiency from evidence provided shall not be construed as a waiver of Contractor's obligation to maintain such insurance.

D. By requiring such insurance and insurance limits herein, Owner does not represent that coverage and limits will necessarily be adequate to protect Contractor, and such coverage and limits shall not be deemed as a limitation on Contractor's liability under the indemnities granted to Owner in the Contract Documents.

#### 5.04 *Contractor's Liability Insurance*

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

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

2. claims for damages because of bodily injury, occupational sickness or disease, or death of Contractor's employees;

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

4. claims for damages insured by reasonably available personal injury liability coverage which are sustained:

a. by any person as a result of an offense directly or indirectly related to the employment of such person by Contractor, or

b. by any other person for any other reason;

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

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.

B. The policies of insurance required by this Paragraph 5.04 shall:

1. with respect to insurance required by Paragraphs 5.04.A.3 through 5.04.A.6 inclusive, include as additional insured (subject to any customary exclusion

regarding professional liability) Owner and Engineer, and any other individuals or entities identified in the Supplementary Conditions, all of whom shall be listed as additional insureds, and include coverage for the respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of all such additional insureds, and the insurance afforded to these additional insureds shall provide primary coverage for all claims covered thereby;

2. include at least the specific coverages and be written for not less than the limits of liability provided in the Supplementary Conditions or required by Laws or Regulations, whichever is greater;

3. include completed operations insurance;

4. include contractual liability insurance covering Contractor's indemnity obligations under Paragraphs 6.11 and 6.20;

5. contain a provision or endorsement that the coverage afforded will not be canceled, materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and Contractor and to each other additional insured identified in the Supplementary Conditions to whom a certificate of insurance has been issued (and the certificates of insurance furnished by the Contractor pursuant to Paragraph 5.03 will so provide);

6. 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 13.07; and

7. with respect to completed operations insurance, and any insurance coverage written on a claims-made basis, remain in effect for at least two years after final payment.

a. Contractor shall furnish Owner and each other additional insured identified 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.

#### 5.05 *Owner's Liability Insurance*

A. In addition to the insurance required to be provided by Contractor under Paragraph 5.04, Owner, at Owner's option, may purchase and maintain at Owner's expense Owner's own liability insurance as will protect Owner against claims which may arise from operations under the Contract Documents.

## 5.06 *Property Insurance*

A. Unless otherwise provided in the Supplementary Conditions, Owner shall purchase and maintain property insurance upon the Work at the Site in the amount of the full replacement cost thereof (subject to such deductible amounts as may be provided in the Supplementary Conditions or required by Laws and Regulations). This insurance shall:

1. include the interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;

2. be written on a Builder's Risk "all-risk" or open peril or special causes of loss policy form that shall at least include insurance for physical loss or damage to the Work, temporary buildings, false work, and materials and equipment in transit, and shall insure against at least the following perils or causes of loss: fire, lightning, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage, (other than caused by flood) and such other perils or causes of loss as may be specifically required by the Supplementary Conditions;

3. include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);

4. cover materials and equipment stored at the Site or at another location that was agreed to in writing by Owner prior to being incorporated in the Work, provided that such materials and equipment have been included in an Application for Payment recommended by Engineer;

5. allow for partial utilization of the Work by Owner;

6. include testing and startup; and

7. be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, Contractor, and Engineer with 30 days written notice to each other additional insured to whom a certificate of insurance has been issued.

B. 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 interests of Owner, Contractor, Subcontractors, and Engineer, and any other individuals or entities identified in the Supplementary Conditions, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them, each of whom is

deemed to have an insurable interest and shall be listed as an insured or additional insured.

C. All the policies of insurance (and the certificates or other evidence thereof) required to be purchased and maintained in accordance with Paragraph 5.06 will contain a provision or endorsement that the coverage afforded will not be canceled or materially changed or renewal refused until at least 30 days prior written notice has been given to Owner and 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 5.07.

D. Owner shall not be responsible for purchasing and maintaining any property insurance specified in this Paragraph 5.06 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 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.

E. If Contractor requests in writing that other special insurance be included in the property insurance policies provided under Paragraph 5.06, Owner shall, if possible, include such insurance, and the cost thereof will be charged to Contractor by appropriate Change Order. 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.

## 5.07 *Waiver of Rights*

A. Owner and Contractor intend that all policies purchased in accordance with Paragraph 5.06 will protect Owner, Contractor, Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) in such policies and will provide primary coverage for all losses and damages caused by the perils or causes of loss covered 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 insureds or additional insureds thereunder. Owner and Contractor waive all rights against each other and their respective officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for all losses and damages caused by, arising out of or resulting from any of the perils or causes of loss covered by such policies and any other property insurance applicable to the Work; and, in addition, waive all such rights against Subcontractors, and Engineer, and all other individuals or entities identified in the Supplementary Conditions to be listed as insured or additional insured (and the officers, directors,



partners, employees, agents, consultants and subcontractors of each and any of them) under such policies for losses and damages so caused. None of the above waivers shall extend to the rights that any party making such waiver may have to the proceeds of insurance held by Owner as trustee or otherwise payable under any policy so issued.

B. Owner waives all rights against Contractor, Subcontractors, and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them for:

1. loss due to business interruption, loss of use, or other consequential loss extending beyond direct physical loss or damage to Owner's property or the Work caused by, arising out of, or resulting from fire or other perils whether or not insured by Owner; and

2. loss or damage to the completed Project or part thereof caused by, arising out of, or resulting from fire or other insured peril or cause of loss covered by any property insurance maintained on the completed Project or part thereof by Owner during partial utilization pursuant to Paragraph 14.05, after Substantial Completion pursuant to Paragraph 14.04, or after final payment pursuant to Paragraph 14.07.

C. Any insurance policy maintained by Owner covering any loss, damage or consequential loss referred to in Paragraph 5.07.B shall contain provisions to the effect that in the event of payment of any such loss, damage, or consequential loss, the insurers will have no rights of recovery against Contractor, Subcontractors, or Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them.

#### 5.08 *Receipt and Application of Insurance Proceeds*

A. Any insured loss under the policies of insurance required by Paragraph 5.06 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 5.08.B. 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 moneys so received applied on account thereof, and the Work and the cost thereof covered by an appropriate Change Order .

B. 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 15 days after the occurrence of loss to Owner's exercise of this power. If such objection be made, Owner as fiduciary shall make settlement with the insurers in accordance with such agreement as the parties in interest may reach. If no such agreement among the parties in interest is reached,

Owner as fiduciary shall adjust and settle the loss with the insurers and, if required in writing by any party in interest, Owner as fiduciary shall give bond for the proper performance of such duties.

#### 5.09 *Acceptance of Bonds and Insurance; Option to Replace*

A. If either Owner or Contractor has any objection to the coverage afforded by or other provisions of the bonds or insurance required to be purchased and maintained by the other party in accordance with Article 5 on the basis of non-conformance with the Contract Documents, the objecting party shall so notify the other party in writing within 10 days after receipt of the certificates (or other evidence requested) required by Paragraph 2.01.B. Owner and Contractor shall each provide to the other such additional information in respect of insurance provided as the other may reasonably request. If either party does not purchase or maintain all of the bonds and insurance required of such party by the Contract Documents, such party shall notify the other party in writing of such failure to purchase prior to the start of the Work, or of such failure to maintain prior to any change in the required coverage. Without prejudice to any other right or remedy, the other party may elect to obtain equivalent bonds or insurance to protect such other party's interests at the expense of the party who was required to provide such coverage, and a Change Order shall be issued to adjust the Contract Price accordingly.

#### 5.10 *Partial Utilization, Acknowledgment of Property Insurer*

A. If Owner finds it necessary to occupy or use a portion or portions of the Work prior to Substantial Completion of all the Work as provided in Paragraph 14.05, no such use or occupancy shall commence before the insurers providing the property insurance pursuant to Paragraph 5.06 have acknowledged notice thereof and in writing effected any 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 canceled or permitted to lapse on account of any such partial use or occupancy.

### ARTICLE 6 - CONTRACTOR'S RESPONSIBILITIES

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#### 6.01 *Supervision and Superintendence*

A. 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. Contractor shall not be responsible for the negligence of Owner or

Engineer in the design or specification of a specific means, method, technique, sequence, or procedure of construction which is shown or indicated in and expressly required by the Contract Documents.

B. At all times during the progress of the Work, Contractor shall assign a competent resident superintendent who shall not be replaced without written notice to Owner and Engineer except under extraordinary circumstances. The superintendent will be Contractor's representative at the Site and shall have authority to act on behalf of Contractor. All communications given to or received from the superintendent shall be binding on Contractor.

#### 6.02 *Labor; Working Hours*

A. 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.

B. 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 stated in the Contract Documents, all Work at the Site shall be performed during regular working hours. Contractor will not permit the performance of Work on a Saturday, Sunday, or any legal holiday without Owner's written consent (which will not be unreasonably withheld) given after prior written notice to Engineer.

#### 6.03 *Services, Materials, and Equipment*

A. Unless otherwise specified in the Contract Documents, Contractor shall provide and assume full responsibility for all services, materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities, and all other facilities and incidentals necessary for the performance, testing, start-up, and completion of the Work.

B. All materials and equipment incorporated into the Work shall be as specified or, if not specified, shall be of good quality and new, except as otherwise provided in the Contract Documents. All special warranties and guarantees required 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 source, kind, and quality of materials and equipment.

C. All materials and equipment shall be stored, applied, installed, connected, erected, protected, used, cleaned, and conditioned in accordance with instructions of the applicable Supplier, except as otherwise may be provided in the Contract Documents.

#### 6.04 *Progress Schedule*

A. Contractor shall adhere to the Progress Schedule established in accordance with Paragraph 2.07 as it may be adjusted from time to time as provided below.

1. Contractor shall submit to Engineer for acceptance (to the extent indicated in Paragraph 2.07) proposed adjustments in the Progress Schedule that will not result in changing the Contract Times. Such adjustments will comply with any provisions of the General Requirements applicable thereto.

2. Proposed adjustments in the Progress Schedule that will change the Contract Times shall be submitted in accordance with the requirements of Article 12. Adjustments in Contract Times may only be made by a Change Order.

#### 6.05 *Substitutes and "Or-Equals"*

A. 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, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading that no like, equivalent, or "or-equal" item or no substitution is permitted, other items of material or equipment or material or equipment of other Suppliers may be submitted to Engineer for review under the circumstances described below.

1. "*Or-Equal*" Items: If in Engineer's sole discretion an item of material or equipment proposed by Contractor is functionally equal to that named and sufficiently similar so that no change in related Work will be required, it may be considered by Engineer as an "or-equal" item, in which case review and approval of the proposed item may, in Engineer's sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph 6.05.A.1, a proposed item of material or equipment will be considered functionally equal to an item so named if:

a. in the exercise of reasonable judgment Engineer determines that:

1) it is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics;

2) it will reliably perform at least equally well the function and achieve the results imposed by the design concept of the completed Project as a functioning whole,

3) it has a proven record of performance and availability of responsive service; and

b. Contractor certifies that, if approved and incorporated into the Work:

1) there will be no increase in cost to the Owner or increase in Contract Times, and

2) it will conform substantially to the detailed requirements of the item named in the Contract Documents.

## 2. Substitute Items

a. If in Engineer's sole discretion an item of material or equipment proposed by Contractor does not qualify as an "or-equal" item under Paragraph 6.05.A.1, it will be considered a proposed substitute item.

b. Contractor shall submit sufficient information as provided below to allow Engineer to determine that the item of material or equipment proposed is essentially equivalent to that named and an acceptable substitute therefor. Requests for review of proposed substitute items of material or equipment will not be accepted by Engineer from anyone other than Contractor.

c. The requirements for review by Engineer will be as set forth in Paragraph 6.05.A.2.d, as supplemented in the General Requirements and as Engineer may decide is appropriate under the circumstances.

d. Contractor shall make written application to Engineer for review of a proposed substitute item of material or equipment that Contractor seeks to furnish or use. The application:

1) shall certify that the proposed substitute item will:

a) perform adequately the functions and achieve the results called for by the general design,

b) be similar in substance to that specified, and

c) be suited to the same use as that specified;

2) will state:

a) the extent, if any, to which the use of the proposed substitute item will prejudice Contractor's achievement of Substantial Completion on time;

b) whether or not use of the proposed substitute item in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with Owner for other work on the Project) to adapt the design to the proposed substitute item; and

c) whether or not incorporation or use of the proposed substitute item in connection with the Work is subject to payment of any license fee or royalty;

3) will identify:

a) all variations of the proposed substitute item from that specified, and

b) available engineering, sales, maintenance, repair, and replacement services;

4) and shall contain an itemized estimate of all costs or credits that will result directly or indirectly from use of such substitute item, including costs of redesign and claims of other contractors affected by any resulting change,

*B. Substitute Construction Methods or Procedures:* If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction approved by Engineer. Contractor shall submit sufficient information to allow Engineer, in Engineer's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by Engineer will be similar to those provided in Paragraph 6.05.A.2.

*C. Engineer's Evaluation:* Engineer will be allowed a reasonable time within which to evaluate each proposal or submittal made pursuant to Paragraphs 6.05.A and 6.05.B. Engineer may require Contractor to furnish additional data about the proposed substitute item. Engineer will be the sole judge of acceptability. No "or equal" or substitute will be ordered, installed or utilized until Engineer's review is complete, which will be evidenced by either a Change Order for a substitute or an approved Shop Drawing for an "or equal." Engineer will advise Contractor in writing of any negative determination.

*D. Special Guarantee:* Owner may require Contractor to furnish at Contractor's expense a special performance guarantee or other surety with respect to any substitute.

E. *Engineer's Cost Reimbursement*: Engineer will record Engineer's costs in evaluating a substitute proposed or submitted by Contractor pursuant to Paragraphs 6.05.A.2 and 6.05.B Whether or not Engineer approves a substitute item so proposed or submitted by Contractor, Contractor shall reimburse Owner for the charges of Engineer for evaluating each such proposed substitute. Contractor shall also reimburse Owner for the charges of Engineer for making changes in the Contract Documents (or in the provisions of any other direct contract with Owner) resulting from the acceptance of each proposed substitute.

F. *Contractor's Expense*: Contractor shall provide all data in support of any proposed substitute or "or-equal" at Contractor's expense.

#### 6.06 *Concerning Subcontractors, Suppliers, and Others*

A. Contractor shall not employ any Subcontractor, Supplier, or other individual or entity (including those acceptable to Owner as indicated in Paragraph 6.06.B), whether initially or as a replacement, against whom Owner may have reasonable objection. Contractor shall not be required to employ any Subcontractor, Supplier, or other individual or entity to furnish or perform any of the Work against whom Contractor has reasonable objection.

B. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, or other individuals or entities to be submitted to Owner in advance for acceptance by Owner by a specified date prior to the Effective Date of the Agreement, and if Contractor has submitted a list thereof in accordance with the Supplementary Conditions, Owner'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 individual or entity so identified may be revoked on the basis of reasonable objection after due investigation. Contractor shall submit an acceptable replacement for the rejected Subcontractor, Supplier, or other individual or entity, and the Contract Price will be adjusted by the difference in the cost occasioned by such replacement, and an appropriate Change Order will be issued. No acceptance by Owner of any such Subcontractor, Supplier, or other individual or entity, whether initially or as a replacement, shall constitute a waiver of any right of Owner or Engineer to reject defective Work.

C. Contractor shall be fully responsible to Owner and Engineer for all acts and omissions of the Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work just as Contractor is responsible for Contractor's own acts and omissions. Nothing in the Contract Documents:

1. shall create for the benefit of any such Subcontractor, Supplier, or other individual or entity any contractual relationship between Owner or Engineer and any such Subcontractor, Supplier or other individual or entity, nor

2. shall anything in the Contract Documents create any obligation on the part of Owner or Engineer to pay or to see to the payment of any moneys due any such Subcontractor, Supplier, or other individual or entity except as may otherwise be required by Laws and Regulations.

D. Contractor shall be solely responsible for scheduling and coordinating the Work of Subcontractors, Suppliers, and other individuals or entities performing or furnishing any of the Work under a direct or indirect contract with Contractor.

E. Contractor shall require all Subcontractors, Suppliers, and such other individuals or entities performing or furnishing any of the Work to communicate with Engineer through Contractor.

F. The divisions and sections of the Specifications and the identifications 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.

G. All Work performed for Contractor by a Subcontractor or Supplier will be pursuant to an appropriate agreement between Contractor and the Subcontractor or Supplier which specifically binds the Subcontractor or Supplier to the applicable terms and conditions of the Contract Documents for the benefit of Owner and Engineer. Whenever any such agreement is with a Subcontractor or Supplier who is listed as an additional insured on the property insurance provided in Paragraph 5.06, the agreement between the Contractor and the Subcontractor or Supplier will contain provisions whereby the Subcontractor or Supplier waives all rights against Owner, Contractor, and Engineer,, and all other individuals or entities identified in the Supplementary Conditions to be listed as insureds or additional insureds (and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them) for all losses and damages caused by, arising out of, relating to, or resulting from any of the perils or causes of loss 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.

#### 6.07 *Patent Fees and Royalties*

A. Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product, or device

which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product, or device is specified in the Contract Documents for use in the performance of the Work and if to the actual knowledge of Owner or Engineer its use is subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by Owner in the Contract Documents.

B. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to 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.

#### 6.08 *Permits*

A. 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. Owner shall pay all charges of utility owners for connections for providing permanent service to the Work.

#### 6.09 *Laws and Regulations*

A. Contractor shall give all notices required by and shall comply with all Laws and Regulations applicable to the 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.

B. If Contractor performs any Work knowing or having reason to know that it is contrary to Laws or Regulations, Contractor shall bear all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such Work. However, it shall not be Contractor's primary responsibility to make certain that the Specifications and Drawings are in accordance with Laws and Regulations, but this shall not relieve Contractor of Contractor's obligations under Paragraph 3.03.

C. Changes in Laws or Regulations not known at the time of opening of Bids (or, on the Effective Date of the Agreement if there were no Bids) having an effect on the cost or time of performance of the Work shall be the subject of an adjustment in Contract Price or Contract Times. If Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

#### 6.10 *Taxes*

A. 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.

#### 6.11 *Use of Site and Other Areas*

##### A. Limitation on Use of Site and Other Areas

1. Contractor shall confine construction equipment, the storage of materials and equipment, and the operations of workers to the Site and other areas permitted by Laws and Regulations, and shall not unreasonably encumber the Site and other areas 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.

2. Should any claim be made by any such owner or occupant because of the performance of the Work, Contractor shall promptly settle with such other party by negotiation or otherwise resolve the claim by arbitration or other dispute resolution proceeding or at law.

3. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to any claim or action, legal or equitable, brought by any such owner or occupant against Owner, Engineer, or any other party indemnified hereunder to the extent caused by or based upon Contractor's performance of the Work.

B. *Removal of Debris During Performance of the Work:* During the progress of the Work Contractor shall keep the Site and other areas free from accumulations of waste materials, rubbish, and other debris. Removal and disposal of such waste materials, rubbish, and other debris shall conform to applicable Laws and Regulations.

C. *Cleaning*: Prior to Substantial Completion of the Work Contractor shall clean the Site and the Work and make it ready for utilization by Owner. At the completion of the Work Contractor shall remove from the Site all tools, appliances, construction equipment and machinery, and surplus materials and shall restore to original condition all property not designated for alteration by the Contract Documents.

D. *Loading Structures*: Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

#### 6.12 *Record Documents*

A. Contractor shall maintain in a safe place at the Site one record copy of all Drawings, Specifications, Addenda, Change Orders, Work Change Directives, Field Orders, and written interpretations and clarifications in good order and annotated to show 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.

#### 6.13 *Safety and Protection*

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

1. all persons on the Site or who may be affected by the Work;
2. all the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site; and
3. other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction.

B. Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property 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 other 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.

C. All damage, injury, or loss to any property referred to in Paragraph 6.13.A.2 or 6.13.A.3 caused, directly or indirectly, in whole or in part, by Contractor, any Subcontractor, Supplier, or any other individual or entity directly or indirectly employed by any of them to perform 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 , 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 individual or entity directly or indirectly employed by any of them).

D. Contractor's duties and responsibilities for safety and for protection of the Work shall continue until such time as all the Work is completed and Engineer has issued a notice to Owner and Contractor in accordance with Paragraph 14.07.B that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

#### 6.14 *Safety Representative*

A. Contractor shall designate a qualified and experienced safety representative at the Site whose duties and responsibilities shall be the prevention of accidents and the maintaining and supervising of safety precautions and programs.

#### 6.15 *Hazard Communication Programs*

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

#### 6.16 *Emergencies*

A. In emergencies affecting the safety or protection of persons or the Work or property at the Site or adjacent thereto, Contractor 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 or are required as a result thereof. 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.

## 6.17 *Shop Drawings and Samples*

A. Contractor shall submit Shop Drawings and Samples to Engineer for review and approval in accordance with the acceptable Schedule of Submittals (as required by Paragraph 2.07). Each submittal will be identified as Engineer may require.

### 1. Shop Drawings

a. Submit number of copies specified in the General Requirements.

b. 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 services, materials, and equipment Contractor proposes to provide and to enable Engineer to review the information for the limited purposes required by Paragraph 6.17.D.

2. *Samples*: Contractor shall also submit Samples to Engineer for review and approval in accordance with the acceptable schedule of Shop Drawings and Sample submittals.

a. Submit number of Samples specified in the Specifications.

b. Clearly identify each Sample as to material, Supplier, pertinent data such as catalog numbers, the use for which intended and other data as Engineer may require to enable Engineer to review the submittal for the limited purposes required by Paragraph 6.17.D.

B. Where a Shop Drawing or Sample is required by the Contract Documents or the Schedule of Submittals, 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.

### C. Submittal Procedures

1. Before submitting each Shop Drawing or Sample, Contractor shall have determined and verified:

a. all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto;

b. the suitability of all materials with respect to intended use, fabrication, shipping, handling, storage, assembly, and installation pertaining to the performance of the Work;

c. all information relative to Contractor's responsibilities for means, methods, techniques,

sequences, and procedures of construction, and safety precautions and programs incident thereto; and

d. 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.

2. Each submittal shall bear a stamp or specific written certification that Contractor has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review and approval of that submittal.

3. With each submittal, Contractor shall give Engineer specific written notice of any variations, that the Shop Drawing or Sample may have from the requirements of the Contract Documents. This notice shall be both a written communication separate from the Shop Drawing's or Sample Submittal; and, in addition, by a specific notation made on each Shop Drawing or Sample submitted to Engineer for review and approval of each such variation.

### D. *Engineer's Review*

1. Engineer will provide timely review of Shop Drawings and Samples in accordance with the Schedule of Submittals acceptable to Engineer. 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.

2. Engineer's review and approval will not extend to means, methods, techniques, sequences, or procedures of construction (except where a particular 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.

3. Engineer's review and approval shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents unless Contractor has complied with the requirements of Paragraph 6.17.C.3 and Engineer has given written approval of each such variation by specific written notation thereof incorporated in or accompanying the Shop Drawing or Sample. Engineer's review and approval shall not relieve Contractor from responsibility for complying with the requirements of Paragraph 6.17.C.1.

### E. *Resubmittal Procedures*

1. 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.

#### 6.18 *Continuing the Work*

A. Contractor shall carry on the Work and adhere to the Progress Schedule during all disputes or disagreements with Owner. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as permitted by Paragraph 15.04 or as Owner and Contractor may otherwise agree in writing.

#### 6.19 *Contractor's General Warranty and Guarantee*

A. Contractor warrants and guarantees to Owner that all Work will be in accordance with the Contract Documents and will not be defective. Engineer and its Related Entities shall be entitled to rely on representation of Contractor's warranty and guarantee.

B. Contractor's warranty and guarantee hereunder excludes defects or damage caused by:

1. abuse, modification, or improper maintenance or operation by persons other than Contractor, Subcontractors, Suppliers, or any other individual or entity for whom Contractor is responsible; or

2. normal wear and tear under normal usage.

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

1. observations by Engineer;

2. recommendation by Engineer or payment by Owner of any progress or final payment;

3. the issuance of a certificate of Substantial Completion by Engineer or any payment related thereto by Owner;

4. use or occupancy of the Work or any part thereof by Owner;

5. any review and approval of a Shop Drawing or Sample submittal or the issuance of a notice of acceptability by Engineer;

6. any inspection, test, or approval by others; or

7. any correction of defective Work by Owner.

#### 6.20 *Indemnification*

A. To the fullest extent permitted by Laws and Regulations, Contractor shall indemnify and hold harmless Owner and Engineer, and the officers, directors, partners, employees, agents, consultants and subcontractors of each and any of them from and against all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to the performance of the Work, provided that any such claim, cost, loss, or damage is attributable to bodily injury, sickness, disease, or death, or to injury to or destruction of tangible property (other than the Work itself), including the loss of use resulting therefrom but only to the extent caused by any negligent act or omission of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work or anyone for whose acts any of them may be liable.

B. In any and all claims against Owner or Engineer or any of their respective consultants, agents, officers, directors, partners, or employees by any employee (or the survivor or personal representative of such employee) of Contractor, any Subcontractor, any Supplier, or any individual or entity directly or indirectly employed by any of them to perform any of the Work, or anyone for whose acts any of them may be liable, the indemnification obligation under Paragraph 6.20.A 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 individual or entity under workers' compensation acts, disability benefit acts, or other employee benefit acts.

C. The indemnification obligations of Contractor under Paragraph 6.20.A shall not extend to the liability of Engineer and Engineer's officers, directors, partners, employees, agents, consultants and subcontractors arising out of:

1. the preparation or approval of, or the failure to prepare or approve, maps, Drawings, opinions, reports, surveys, Change Orders, designs, or Specifications; or

2. giving directions or instructions, or failing to give them, if that is the primary cause of the injury or damage.

#### 6.21 *Delegation of Professional Design Services*

A. Contractor will not be required to provide professional design services unless such services are specifically required by the Contract Documents for a



portion of the Work or unless such services are required to carry out Contractor's responsibilities for construction means, methods, techniques, sequences and procedures. Contractor shall not be required to provide professional services in violation of applicable law.

B. If professional design services or certifications by a design professional related to systems, materials or equipment are specifically required of Contractor by the Contract Documents, Owner and Engineer will specify all performance and design criteria that such services must satisfy. Contractor shall cause such services or certifications to be provided by a properly licensed professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings and other submittals prepared by such professional. Shop Drawings and other submittals related to the Work designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to Engineer.

C. Owner and Engineer shall be entitled to rely upon the adequacy, accuracy and completeness of the services, certifications or approvals performed by such design professionals, provided Owner and Engineer have specified to Contractor all performance and design criteria that such services must satisfy.

D. Pursuant to this Paragraph 6.21, Engineer's review and approval of design calculations and design drawings will be only for the limited purpose of checking for conformance with performance and design criteria given and the design concept expressed in the Contract Documents. Engineer's review and approval of Shop Drawings and other submittals (except design calculations and design drawings) will be only for the purpose stated in Paragraph 6.17.D.1.

E. Contractor shall not be responsible for the adequacy of the performance or design criteria required by the Contract Documents.

## ARTICLE 7 - OTHER WORK AT THE SITE

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### 7.01 *Related Work at Site*

A. Owner may perform other work related to the Project at the Site with Owner's employees, or via other direct contracts therefor, or have other work performed by utility owners. If such other work is not noted in the Contract Documents, then:

1. written notice thereof will be given to Contractor prior to starting any such other work; and

2. if Owner and Contractor are unable to agree on entitlement to or on the amount or extent, if any, of any adjustment in the Contract Price or Contract Times

that should be allowed as a result of such other work, a Claim may be made therefor as provided in Paragraph 10.05.

B. Contractor shall afford each other contractor who is a party to such a direct contract, each utility owner and Owner, if Owner is performing other work with Owner's employees, proper and safe access to the Site, a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such other work, and shall properly coordinate the Work with theirs. Contractor shall do all cutting, fitting, and patching of the Work that may be required to properly connect or otherwise make its several parts come together and properly 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.

C. 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 other work that render it unavailable or unsuitable for the proper execution and results of Contractor's Work. Contractor's failure to so report will constitute an acceptance of such other work as fit and proper for integration with Contractor's Work except for latent defects and deficiencies in such other work.

### 7.02 *Coordination*

A. If Owner intends to contract with others for the performance of other work on the Project at the Site, the following will be set forth in Supplementary Conditions:

1. the individual or entity who will have authority and responsibility for coordination of the activities among the various contractors will be identified;

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

3. the extent of such authority and responsibilities will be provided.

B. Unless otherwise provided in the Supplementary Conditions, Owner shall have sole authority and responsibility for such coordination.

### 7.03 *Legal Relationships*

A. Paragraphs 7.01.A and 7.02 are not applicable for utilities not under the control of Owner.

B. Each other direct contract of Owner under Paragraph 7.01.A shall provide that the other contractor is liable to Owner and Contractor for the reasonable direct delay and disruption costs incurred by Contractor as a result of the other contractor's actions or inactions.

C. Contractor shall be liable to Owner and any other contractor for the reasonable direct delay and disruption costs incurred by such other contractor as a result of Contractor's action or inactions.

## ARTICLE 8 - OWNER'S RESPONSIBILITIES

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### 8.01 *Communications to Contractor*

A. Except as otherwise provided in these General Conditions, Owner shall issue all communications to Contractor through Engineer.

### 8.02 *Replacement of Engineer*

A. In case of termination of the employment of Engineer, Owner shall appoint an engineer to whom Contractor makes no reasonable objection, whose status under the Contract Documents shall be that of the former Engineer.

### 8.03 *Furnish Data*

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

### 8.04 *Pay When Due*

A. Owner shall make payments to Contractor when they are due as provided in Paragraphs 14.02.C and 14.07.C.

### 8.05 *Lands and Easements; Reports and Tests*

A. Owner's duties in respect of providing lands and easements and providing engineering surveys to establish reference points are set forth in Paragraphs 4.01 and 4.05. Paragraph 4.02 refers to Owner's identifying and making available to Contractor copies of reports of explorations and tests of subsurface conditions and drawings of physical conditions in or relating to existing surface or subsurface structures at or contiguous to the Site that have been utilized by Engineer in preparing the Contract Documents.

### 8.06 *Insurance*

A. Owner's responsibilities, if any, in respect to purchasing and maintaining liability and property insurance are set forth in Article 5.

### 8.07 *Change Orders*

A. Owner is obligated to execute Change Orders as indicated in Paragraph 10.03.

### 8.08 *Inspections, Tests, and Approvals*

A. Owner's responsibility in respect to certain inspections, tests, and approvals is set forth in Paragraph 13.03.B.

### 8.09 *Limitations on Owner's Responsibilities*

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

### 8.10 *Undisclosed Hazardous Environmental Condition*

A. Owner's responsibility in respect to an undisclosed Hazardous Environmental Condition is set forth in Paragraph 4.06.

### 8.11 *Evidence of Financial Arrangements*

A. If and to the extent Owner has agreed to furnish Contractor reasonable evidence that financial arrangements have been made to satisfy Owner's obligations under the Contract Documents, Owner's responsibility in respect thereof will be as set forth in the Supplementary Conditions.

## ARTICLE 9 - ENGINEER'S STATUS DURING CONSTRUCTION

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### 9.01 *Owner's Representative*

A. Engineer will be Owner's representative during the construction period. The duties and responsibilities and the limitations of authority of Engineer as Owner's representative during construction are set forth in the Contract Documents and will not be changed without written consent of Owner and Engineer.

### 9.02 *Visits to Site*

A. 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, for the benefit of Owner, will determine, in general, if the Work is proceeding in accordance with the Contract Documents. Engineer will not be required to make exhaustive or continuous inspections on the Site 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 observations, Engineer will keep Owner informed of the progress of the Work and will endeavor to guard Owner against defective Work.

B. Engineer's visits and observations are subject to all the limitations on Engineer's authority and responsibility set forth in Paragraph 9.09. Particularly, but without limitation, during or as a result of Engineer's visits or observations of Contractor's Work 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 performance of the Work.

#### 9.03 *Project Representative*

A. If Owner and Engineer agree, Engineer will furnish a Resident Project Representative to assist Engineer in providing more extensive observation of the Work. The authority and responsibilities of any such Resident Project Representative and assistants will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in Paragraph 9.09. If Owner designates another representative or agent to represent Owner at the Site who is not Engineer's consultant, agent or employee, the responsibilities and authority and limitations thereon of such other individual or entity will be as provided in the Supplementary Conditions.

#### 9.04 *Authorized Variations in Work*

A. 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 completed 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 Owner or Contractor believes that a Field Order justifies an adjustment in the Contract Price or Contract Times, or both, and the parties are unable to agree on entitlement to or on the amount or extent, if any, of any such adjustment, a Claim may be made therefor as provided in Paragraph 10.05.

#### 9.05 *Rejecting Defective Work*

A. Engineer will have authority to 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 13.04, whether or not the Work is fabricated, installed, or completed.

#### 9.06 *Shop Drawings, Change Orders and Payments*

A. In connection with Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, see Paragraph 6.17.

B. In connection with Engineer's authority, and limitations thereof, as to design calculations and design drawings submitted in response to a delegation of professional design services, if any, see Paragraph 6.21.

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

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

#### 9.07 *Determinations for Unit Price Work*

A. Engineer will determine the actual quantities and classifications of Unit Price Work performed by Contractor. Engineer will review with Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of an Application for Payment or otherwise). Engineer's written decision thereon will be final and binding (except as modified by Engineer to reflect changed factual conditions or more accurate data) upon Owner and Contractor, subject to the provisions of Paragraph 10.05.

#### 9.08 *Decisions on Requirements of Contract Documents and Acceptability of Work*

A. Engineer will be the initial interpreter of the requirements of the Contract Documents and judge of the acceptability of the Work thereunder. All matters in question and other matters between Owner and Contractor arising prior to the date final payment is due relating to the acceptability of the Work, and the interpretation of the requirements of the Contract Documents pertaining to the performance of the Work, will be referred initially to Engineer in writing within 30 days of the event giving rise to the question.

B. Engineer will, with reasonable promptness, render a written decision on the issue referred. If Owner or Contractor believe that any such decision entitles them

to an adjustment in the Contract Price or Contract Times or both, a Claim may be made under Paragraph 10.05. The date of Engineer's decision shall be the date of the event giving rise to the issues referenced for the purposes of Paragraph 10.05.B.

C. Engineer's written decision on the issue referred will be final and binding on Owner and Contractor, subject to the provisions of Paragraph 10.05.

D. When functioning as interpreter and judge under this Paragraph 9.08, Engineer will not show partiality to Owner or Contractor and will not be liable in connection with any interpretation or decision rendered in good faith in such capacity.

#### *9.09 Limitations on Engineer's Authority and Responsibilities*

A. Neither Engineer's authority or responsibility under this Article 9 or under any other provision of the Contract Documents 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 in contract, tort, or otherwise owed by Engineer to Contractor, any Subcontractor, any Supplier, any other individual or entity, or to any surety for or employee or agent of any of them.

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

C. Engineer will not be responsible for the acts or omissions of Contractor or of any Subcontractor, any Supplier, or of any other individual or entity performing any of the Work.

D. Engineer's review of the final Application for Payment and accompanying documentation and all maintenance and operating instructions, schedules, guarantees, bonds, certificates of inspection, tests and approvals, and other documentation required to be delivered by Paragraph 14.07.A will only be to determine generally that their content complies with the requirements of, and in the case of certificates of inspections, tests, and approvals that the results certified indicate compliance with the Contract Documents.

E. The limitations upon authority and responsibility set forth in this Paragraph 9.09 shall also apply to, the Resident Project Representative, if any, and assistants, if any.

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## ARTICLE 10 - CHANGES IN THE WORK; CLAIMS

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### *10.01 Authorized Changes in the Work*

A. Without invalidating the Contract and without notice to any surety, Owner may, at any time or from time to time, order additions, deletions, or revisions in the Work by 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).

B. If Owner and Contractor are unable to agree on entitlement to, or on the amount or extent, if any, of an adjustment in the Contract Price or Contract Times, or both, that should be allowed as a result of a Work Change Directive, a Claim may be made therefor as provided in Paragraph 10.05.

### *10.02 Unauthorized Changes in the Work*

A. Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any work performed that is not required by the Contract Documents as amended, modified, or supplemented as provided in Paragraph 3.04, except in the case of an emergency as provided in Paragraph 6.16 or in the case of uncovering Work as provided in Paragraph 13.04.B.

### *10.03 Execution of Change Orders*

A. Owner and Contractor shall execute appropriate Change Orders recommended by Engineer covering:

1. changes in the Work which are: (i) ordered by Owner pursuant to Paragraph 10.01.A, (ii) required because of acceptance of defective Work under Paragraph 13.08.A or Owner's correction of defective Work under Paragraph 13.09, or (iii) agreed to by the parties;

2. changes in the Contract Price or Contract Times which are agreed to by the parties, including any undisputed sum or amount of time for Work actually performed in accordance with a Work Change Directive; and

3. changes in the Contract Price or Contract Times which embody the substance of any written decision rendered by Engineer pursuant to Paragraph 10.05; 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 6.18.A.

#### 10.04 *Notification to Surety*

A. 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. The amount of each applicable bond will be adjusted to reflect the effect of any such change.

#### 10.05 *Claims*

A. *Engineer's Decision Required:* All Claims, except those waived pursuant to Paragraph 14.09, shall be referred to the Engineer for decision. A decision by Engineer shall be required as a condition precedent to any exercise by Owner or Contractor of any rights or remedies either may otherwise have under the Contract Documents or by Laws and Regulations in respect of such Claims.

B. *Notice:* Written notice stating the general nature of each Claim, shall be delivered by the claimant to Engineer and the other party to the Contract promptly (but in no event later than 30 days) after the start of the event giving rise thereto. The responsibility to substantiate a Claim shall rest with the party making the Claim. Notice of the amount or extent of the Claim, with supporting data shall be delivered to the Engineer and the other party to the Contract within 60 days after the start of such event (unless Engineer allows additional time for claimant to submit additional or more accurate data in support of such Claim). A Claim for an adjustment in Contract Price shall be prepared in accordance with the provisions of Paragraph 12.01.B. A Claim for an adjustment in Contract Time shall be prepared in accordance with the provisions of Paragraph 12.02.B. Each Claim shall be accompanied by claimant's written statement that the adjustment claimed is the entire adjustment to which the claimant believes it is entitled as a result of said event. The opposing party shall submit any response to Engineer and the claimant within 30 days after receipt of the claimant's last submittal (unless Engineer allows additional time).

C. *Engineer's Action:* Engineer will review each Claim and, within 30 days after receipt of the last submittal of the claimant or the last submittal of the opposing party, if any, take one of the following actions in writing:

1. deny the Claim in whole or in part,

2. approve the Claim, or

3. notify the parties that the Engineer is unable to resolve the Claim if, in the Engineer's sole discretion, it would be inappropriate for the Engineer to do so. For purposes of further resolution of the Claim, such notice shall be deemed a denial.

D. In the event that Engineer does not take action on a Claim within said 30 days, the Claim shall be deemed denied.

E. Engineer's written action under Paragraph 10.05.C or denial pursuant to Paragraphs 10.05.C.3 or 10.05.D will be final and binding upon Owner and Contractor, unless Owner or Contractor invoke the dispute resolution procedure set forth in Article 16 within 30 days of such action or denial.

F. No Claim for an adjustment in Contract Price or Contract Times will be valid if not submitted in accordance with this Paragraph 10.05.

### ARTICLE 11 - COST OF THE WORK; ALLOWANCES; UNIT PRICE WORK

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#### 11.01 *Cost of the Work*

A. *Costs Included:* The term Cost of the Work means the sum of all costs, except those excluded in Paragraph 11.01.B, necessarily incurred and paid by Contractor in the proper performance of the Work. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. 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 11.01.B.

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

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 returns from sale of surplus materials and equipment shall accrue to Owner, and Contractor shall make provisions so that they may be obtained.

3. Payments made by Contractor to Subcontractors for Work performed by Subcontractors. If required by Owner, Contractor shall obtain competitive bids from subcontractors acceptable to Owner and Contractor and shall deliver such bids to Owner, who will then determine, with the advice of Engineer, which bids, if any, will be acceptable. If any subcontract provides that the Subcontractor is to be paid on the basis of Cost of the Work plus a fee, the Subcontractor's Cost of the Work and fee shall be determined in the same manner as Contractor's Cost of the Work and fee as provided in this Paragraph 11.01.

4. Costs of special consultants (including but not limited to Engineers, architects, testing laboratories, surveyors, attorneys, and accountants) employed for services specifically related to the Work.

5. Supplemental costs including the following:

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

b. 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.

c. Rentals of all construction equipment and machinery, and the parts thereof whether rented from Contractor or others in accordance with rental agreements approved by Owner with the advice of Engineer, and the costs of transportation, loading, unloading, assembly, dismantling, and removal thereof. All such costs shall be in accordance with the terms of said rental agreements. The rental of any such equip-

ment, machinery, or parts shall cease when the use thereof is no longer necessary for the Work.

d. Sales, consumer, use, and other similar taxes related to the Work, and for which Contractor is liable, imposed by Laws and Regulations.

e. 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.

f. Losses and damages (and related expenses) caused by damage to the Work, not compensated by insurance or otherwise, sustained by Contractor in connection with the performance of the Work (except losses and damages within the deductible amounts of property insurance established in accordance with Paragraph 5.06.D), provided such losses and damages have resulted from causes other than the negligence of Contractor, any Subcontractor, or anyone directly or indirectly employed by any of them or for whose acts any of them may be liable. Such losses shall include settlements made with the written consent and approval of Owner. No such losses, damages, and expenses shall be included in the Cost of the Work for the purpose of determining Contractor's fee.

g. The cost of utilities, fuel, and sanitary facilities at the Site.

h. Minor expenses such as telegrams, long distance telephone calls, telephone service at the Site, expresses, and similar petty cash items in connection with the Work.

i. The costs of premiums for all bonds and insurance Contractor is required by the Contract Documents to purchase and maintain.

**B. Costs Excluded:** The term Cost of the Work shall not include any of the following items:

1. Payroll costs and other compensation of Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in Paragraph 11.01.A.1 or specifically covered by Paragraph 11.01.A.4, all of which are to be considered administrative costs covered by the Contractor's fee.

2. Expenses of Contractor's principal and branch offices other than Contractor's office at the Site.

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

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

5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraphs 11.01.A and 11.01.B.

*C. Contractor's Fee:* When all the Work is performed on the basis of cost-plus, Contractor's fee shall be determined as set forth in the Agreement. When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of Cost of the Work, Contractor's fee shall be determined as set forth in Paragraph 12.01.C.

*D. Documentation:* Whenever the Cost of the Work for any purpose is to be determined pursuant to Paragraphs 11.01.A and 11.01.B, Contractor will establish and maintain records thereof in accordance with generally accepted accounting practices and submit in a form acceptable to Engineer an itemized cost breakdown together with supporting data.

#### 11.02 Allowances

A. It is understood that Contractor has included in the Contract Price all allowances so named in the Contract Documents and shall cause the Work so covered to be performed for such sums and by such persons or entities as may be acceptable to Owner and Engineer.

##### *B. Cash Allowances*

1. Contractor agrees that:

a. the cash allowances include the cost to Contractor (less any applicable trade discounts) of materials and equipment required by the allowances to be delivered at the Site, and all applicable taxes; and

b. Contractor's costs for unloading and handling on the Site, labor, installation, overhead, profit, and other expenses contemplated for the cash allowances have been included in the Contract Price and not in the allowances, and no demand for additional payment on account of any of the foregoing will be valid.

#### C. Contingency Allowance

1. Contractor agrees that a contingency allowance, if any, is for the sole use of Owner to cover unanticipated costs.

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

#### 11.03 Unit Price Work

A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.

B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by Engineer subject to the provisions of Paragraph 9.07.

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

D. Owner or Contractor may make a Claim for an adjustment in the Contract Price in accordance with Paragraph 10.05 if:

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

2. there is no corresponding adjustment with respect any other item of Work; and

3. Contractor believes that Contractor is entitled to an increase in Contract Price as a result of having incurred additional expense or Owner believes that Owner is entitled to a decrease in Contract Price and the parties are unable to agree as to the amount of any such increase or decrease.

## ARTICLE 12 - CHANGE OF CONTRACT PRICE; CHANGE OF CONTRACT TIMES

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### 12.01 *Change of Contract Price*

A. The Contract Price may only be changed by a Change Order. Any Claim for an adjustment in the Contract Price shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. 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:

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 Paragraph 11.03); or

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 not necessarily in accordance with Paragraph 12.01.C.2); or

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 12.01.B.2, on the basis of the Cost of the Work (determined as provided in Paragraph 11.01) plus a Contractor's fee for overhead and profit (determined as provided in Paragraph 12.01.C).

C. *Contractor's Fee:* The Contractor's fee for overhead and profit shall be determined as follows:

1. a mutually acceptable fixed fee; or

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

a. for costs incurred under Paragraphs 11.01.A.1 and 11.01.A.2, the Contractor's fee shall be 15 percent;

b. for costs incurred under Paragraph 11.01.A.3, the Contractor's fee shall be five percent;

c. where one or more tiers of subcontracts are on the basis of Cost of the Work plus a fee and no fixed fee is agreed upon, the intent of Paragraph 12.01.C.2.a is that the Subcontractor who actually performs the Work, at whatever tier, will be paid a fee of 15 percent of the costs incurred by such Subcontractor under Paragraphs 11.01.A.1 and 11.01.A.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;

d. no fee shall be payable on the basis of costs itemized under Paragraphs 11.01.A.4, 11.01.A.5, and 11.01.B;

e. the amount of credit to be allowed by Contractor to Owner for any change which results in a net decrease in cost will be the amount of the actual net decrease in cost plus a deduction in Contractor's fee by an amount equal to five percent of such net decrease; and

f. when both additions and credits are involved in any one change, the adjustment in Contractor's fee shall be computed on the basis of the net change in accordance with Paragraphs 12.01.C.2.a through 12.01.C.2.e, inclusive.

### 12.02 *Change of Contract Times*

A. The Contract Times may only be changed by a Change Order. Any Claim for an adjustment in the Contract Times shall be based on written notice submitted by the party making the Claim to the Engineer and the other party to the Contract in accordance with the provisions of Paragraph 10.05.

B. Any adjustment of the Contract Times covered by a Change Order or any Claim for an adjustment in the Contract Times will be determined in accordance with the provisions of this Article 12.

### 12.03 *Delays*

A. Where Contractor is prevented from completing any part of the Work within the Contract Times due to delay beyond the control of Contractor, the Contract Times will be extended in an amount equal to the time lost due to such delay if a Claim is made therefor as provided in Paragraph 12.02.A. 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.

B. If Owner, Engineer, or other contractors or utility owners performing other work for Owner as contemplated by Article 7, or anyone for whom Owner is responsible, delays, disrupts, or interferes with the performance or progress of the Work, then Contractor shall be entitled to an equitable adjustment in the Contract Price or the Contract Times, or both. Contractor's entitlement to an adjustment of the Contract Times is conditioned on such adjustment being essential to Contractor's ability to complete the Work within the Contract Times.



C If Contractor is delayed in the performance or progress of the Work by fire, flood, epidemic, abnormal weather conditions, acts of God, acts or failures to act of utility owners not under the control of Owner, or other causes not the fault of and beyond control of Owner and Contractor, then Contractor shall be entitled to an equitable adjustment in Contract Times, if such adjustment is essential to Contractor's ability to complete the Work within the Contract Times. Such an adjustment shall be Contractor's sole and exclusive remedy for the delays described in this Paragraph 12.03.C.

D. Owner, Engineer and the Related Entities of each of them shall not be liable to Contractor for any claims, costs, losses, or damages (including but not limited to all fees and charges of Engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Contractor on or in connection with any other project or anticipated project.

E. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the control of Contractor. Delays attributable to and within the control of a Subcontractor or Supplier shall be deemed to be delays within the control of Contractor.

## ARTICLE 13 - TESTS AND INSPECTIONS; CORRECTION, REMOVAL OR ACCEPTANCE OF DEFECTIVE WORK

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### 13.01 *Notice of Defects*

A. Prompt notice of all defective Work of which Owner or Engineer has actual knowledge will be given to Contractor. All defective Work may be rejected, corrected, or accepted as provided in this Article 13.

### 13.02 *Access to Work*

A. Owner, Engineer, their consultants and other representatives and personnel of Owner, independent testing laboratories, and governmental agencies with jurisdictional interests will have access to the Site and 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 programs so that they may comply therewith as applicable.

### 13.03 *Tests and Inspections*

A. 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.

B. 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:

1. for inspections, tests, or approvals covered by Paragraphs 13.03.C and 13.03.D below;

2. that costs incurred in connection with tests or inspections conducted pursuant to Paragraph 13.04.B shall be paid as provided in said Paragraph 13.04.C; and

3. as otherwise specifically provided in the Contract Documents.

C. 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 inspections, tests, or approvals, pay all costs in connection therewith, and furnish Engineer the required certificates of inspection or approval.

D. Contractor shall be responsible for arranging and obtaining and shall pay all costs in connection with any inspections, tests, or approvals required for Owner's and Engineer's acceptance of materials or equipment to be incorporated in the Work; or acceptance of materials, mix designs, or equipment submitted for approval prior to Contractor's purchase thereof for incorporation in the Work. Such inspections, tests, or approvals shall be performed by organizations acceptable to Owner and Engineer.

E. If any Work (or 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.

F. Uncovering Work as provided in Paragraph 13.03.E 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.

### 13.04 *Uncovering Work*

A. 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.

B. If Engineer considers it necessary or advisable that covered Work be observed by Engineer or inspected or tested by others, Contractor, at Engineer's request, shall uncover, expose, or otherwise make available for observation, inspection, or testing as Engineer may require, that portion of the Work in question, furnishing all necessary labor, material, and equipment.

C. If it is found that the uncovered Work is defective, Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such uncovering, exposure, observation, inspection, and testing, and of satisfactory replacement or reconstruction (including but not limited to all costs of repair or replacement of work of others); and Owner shall be entitled to an appropriate decrease in the Contract Price. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05.

D. If, the uncovered 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 both, directly attributable to such uncovering, exposure, observation, inspection, testing, replacement, and reconstruction. If the parties are unable to agree as to the amount or extent thereof, Contractor may make a Claim therefor as provided in Paragraph 10.05.

#### 13.05 *Owner May Stop the Work*

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

#### 13.06 *Correction or Removal of Defective Work*

A. Promptly after receipt of notice, Contractor shall correct all defective Work, whether or not fabricated, installed, or completed, or, if the Work has been rejected by Engineer, remove it from the Project and replace it with Work that is not defective. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or removal (including but not limited to all costs of repair or replacement of work of others).

B. When correcting defective Work under the terms of this Paragraph 13.06 or Paragraph 13.07, Contractor shall take no action that would void or otherwise impair Owner's special warranty and guarantee, if any, on said Work.

#### 13.07 *Correction Period*

A. If within one year after the date of Substantial Completion (or such longer period of time as may be prescribed 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, or if the repair of any damages to the land or areas made available for Contractor's use by Owner or permitted by Laws and Regulations as contemplated in Paragraph 6.11.A is found to be defective, Contractor shall promptly, without cost to Owner and in accordance with Owner's written instructions:

1. repair such defective land or areas; or

2. correct such defective Work; or

3. if the defective Work has been rejected by Owner, remove it from the Project and replace it with Work that is not defective, and

4. satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.

B. If Contractor does not promptly comply with the terms of Owner's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Owner may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including but not limited to all costs of repair or replacement of work of others) will be paid by Contractor.

C. In special circumstances where a particular item of equipment is placed in continuous service 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 .

D. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph 13.07, 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.

E. Contractor's obligations under this Paragraph 13.07 are in addition to any other obligation or warranty. The provisions of this Paragraph 13.07 shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitation or repose.

### 13.08 *Acceptance of Defective Work*

A. If, instead of requiring correction or removal and replacement of defective Work, Owner (and, prior to Engineer's recommendation of final payment, Engineer) prefers to accept it, Owner may do so. Contractor shall pay all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) attributable to Owner's evaluation of and determination to accept such defective Work (such costs to be approved by Engineer as to reasonableness) and the diminished value of the Work to the extent not otherwise paid by Contractor pursuant to this sentence. 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, reflecting the diminished value of Work so accepted. If the parties are unable to agree as to the amount thereof, Owner may make a Claim therefor as provided in Paragraph 10.05. If the acceptance occurs after such recommendation, an appropriate amount will be paid by Contractor to Owner.

### 13.09 *Owner May Correct Defective Work*

A. If Contractor fails within a reasonable time after written notice from Engineer to correct defective Work or to remove and replace rejected Work as required by Engineer in accordance with Paragraph 13.06.A, 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 or remedy any such deficiency.

B. In exercising the rights and remedies under this Paragraph 13.09, Owner shall proceed expeditiously. In connection with such corrective or 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 consultants access to the Site to enable Owner to exercise the rights and remedies under this Paragraph.

C. All claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred or sustained by Owner in exercising the rights and remedies under this Paragraph 13.09 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. If the parties are unable to agree as to the amount of the adjustment, Owner may make a Claim therefor as provided in Paragraph 10.05. Such claims, costs, losses and damages will include but not be limited to all costs of repair, or replacement of work of others destroyed or damaged by correction, removal, or replacement of Contractor's defective Work.

D. Contractor shall not be allowed an extension of the Contract Times because of any delay in the performance of the Work attributable to the exercise by Owner of Owner's rights and remedies under this Paragraph 13.09.

## ARTICLE 14 - PAYMENTS TO CONTRACTOR AND COMPLETION

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### 14.01 *Schedule of Values*

A. The Schedule of Values established as provided in Paragraph 2.07.A 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.

### 14.02 *Progress Payments*

#### A. Applications for Payments

1. At least 20 days before the date established in the Agreement for each progress payment (but not more often than once a month), 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 requested on the basis of materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing, the Application for Payment shall also be accompanied by 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 or other arrangements to protect Owner's interest therein, all of which must be satisfactory to Owner.

2. Beginning with the second Application for Payment, each Application shall include an affidavit of Contractor stating that all previous progress payments received on account of the Work have been applied on account to discharge Contractor's legitimate obligations associated with prior Applications for Payment.

3. The amount of retainage with respect to progress payments will be as stipulated in the Agreement.

#### *B. Review of Applications*

1. Engineer will, within 10 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.

2. Engineer's recommendation of any payment requested in an Application for Payment will constitute a representation by Engineer to Owner, based on Engineer's observations on the Site of the executed Work as an experienced and qualified design professional 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:

- a. the Work has progressed to the point indicated;
- b. 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 9.07, and to any other qualifications stated in the recommendation); and
- c. 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.

3. By recommending any such payment Engineer will not thereby be deemed to have represented that:

- a. inspections made to check the quality or the quantity of the Work as it has been performed have been exhaustive, extended to every aspect of the Work in progress, or involved detailed inspections of the Work beyond the responsibilities specifically assigned to Engineer in the Contract Documents; or
- b. that there may not be other matters or issues between the parties that might entitle Contractor to be paid additionally by Owner or entitle Owner to withhold payment to Contractor.

4. Neither Engineer's review of Contractor's Work for the purposes of recommending payments nor Engineer's recommendation of any payment, including final payment, will impose responsibility on Engineer:

- a. to supervise, direct, or control the Work, or
- b. for the means, methods, techniques, sequences, or procedures of construction, or the safety precautions and programs incident thereto, or
- c. for Contractor's failure to comply with Laws and Regulations applicable to Contractor's performance of the Work, or
- d. to make any examination to ascertain how or for what purposes Contractor has used the moneys paid on account of the Contract Price, or
- e. to determine that title to any of the Work, materials, or equipment has passed to Owner free and clear of any Liens.

5. Engineer may refuse to recommend the whole or any part of any payment if, in Engineer's opinion, it would be incorrect to make the representations to Owner stated in Paragraph 14.02.B.2. Engineer may also refuse to recommend any such payment or, because of subsequently discovered evidence or the results of subsequent inspections or tests, revise or revoke any such payment recommendation previously made, to such extent as may be necessary in Engineer's opinion to protect Owner from loss because:

- a. the Work is defective, or completed Work has been damaged, requiring correction or replacement;
- b. the Contract Price has been reduced by Change Orders;
- c. Owner has been required to correct defective Work or complete Work in accordance with Paragraph 13.09; or
- d. Engineer has actual knowledge of the occurrence of any of the events enumerated in Paragraph 15.02.A.

#### *C. Payment Becomes Due*

1. Ten days after presentation of the Application for Payment to Owner with Engineer's recommendation, the amount recommended will (subject to the provisions of Paragraph 14.02.D) become due, and when due will be paid by Owner to Contractor.

#### *D. Reduction in Payment*

1. Owner may refuse to make payment of the full amount recommended by Engineer because:

- a. claims have been made against Owner on account of Contractor's performance or furnishing of the Work;
- b. Liens have been filed in connection with the Work, except where Contractor has delivered a specific bond satisfactory to Owner to secure the satisfaction and discharge of such Liens;
- c. there are other items entitling Owner to a set-off against the amount recommended; or
- d. Owner has actual knowledge of the occurrence of any of the events enumerated in Paragraphs 14.02.B.5.a through 14.02.B.5.c or Paragraph 15.02.A.

2. If Owner refuses to make payment of the full amount recommended by Engineer, Owner will give Contractor immediate written notice (with a copy to Engineer) stating the reasons for such action and promptly pay Contractor any amount remaining after deduction of the amount so withheld. Owner shall promptly pay Contractor the amount so withheld, or any adjustment thereto agreed to by Owner and Contractor, when Contractor corrects to Owner's satisfaction the reasons for such action.

3. If it is subsequently determined that Owner's refusal of payment was not justified, the amount wrongfully withheld shall be treated as an amount due as determined by Paragraph 14.02.C.1.

#### *14.03 Contractor's Warranty of Title*

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

#### *14.04 Substantial Completion*

A. When Contractor considers the entire Work ready for its intended use Contractor shall notify Owner and Engineer in writing that the entire Work is substantially complete (except for items specifically listed by Contractor as incomplete) and request that Engineer issue a certificate of Substantial Completion.

B. Promptly after Contractor's notification, , Owner, Contractor, and Engineer shall make an inspection of the Work to determine the status of completion. If Engineer does not consider the Work substantially complete, Engineer will notify Contractor in writing giving the reasons therefor.

C. If Engineer considers the Work substantially complete, Engineer will 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 list. If, after considering such objections, Engineer concludes that the Work is not substantially complete, Engineer will within 14 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 14 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.

D. 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, and protection of the Work, maintenance, heat, utilities, insurance, and warranties and guarantees. Unless Owner and Contractor agree otherwise in writing and so inform Engineer in writing 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.

E. Owner shall have the right to exclude Contractor from the Site after the date of Substantial Completion subject to allowing Contractor reasonable access to complete or correct items on the tentative list.

#### *14.05 Partial Utilization*

A. Prior to Substantial Completion of all the Work, Owner may use or occupy any substantially completed part of the Work which has specifically been identified in the Contract Documents, or which Owner, Engineer, and Contractor agree constitutes a separately functioning and usable 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, subject to the following conditions.

1. Owner at any time may request Contractor in writing to permit Owner to use or occupy any such part of the Work which Owner believes to be ready for its intended use and substantially complete. If and when Contractor agrees that such part of the Work is substantially complete, Contractor will certify to Owner and Engineer that such part of the Work is substantially

complete and request Engineer to issue a certificate of Substantial Completion for that part of the Work.

2. 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.

3. 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 therefor. If Engineer considers that part of the Work to be substantially complete, the provisions of Paragraph 14.04 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.

4. No use or occupancy or separate operation of part of the Work may occur prior to compliance with the requirements of Paragraph 5.10 regarding property insurance.

#### 14.06 *Final Inspection*

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

#### 14.07 *Final Payment*

##### A. Application for Payment

1. After Contractor has, in the opinion of Engineer, satisfactorily completed all corrections identified during the final inspection and has delivered, in accordance with the Contract Documents, all maintenance and operating instructions, schedules, guarantees, bonds, certificates or other evidence of insurance certificates of inspection, marked-up record documents (as provided in Paragraph 6.12), and other documents, Contractor may make application for final payment following the procedure for progress payments.

2. The final Application for Payment shall be accompanied (except as previously delivered) by:

a. all documentation called for in the Contract Documents, including but not limited to the evidence of insurance required by Paragraph 5.04.B.7;

b. consent of the surety, if any, to final payment;

c. a list of all Claims against Owner that Contractor believes are unsettled; and

d. complete and legally effective releases or waivers (satisfactory to Owner) of all Lien rights arising out of or Liens filed in connection with the Work.

3. In lieu of the releases or waivers of Liens specified in Paragraph 14.07.A.2 and as approved by Owner, Contractor may furnish receipts or releases in full and an affidavit of Contractor that: (i) the releases and receipts include all labor, services, material, and equipment for which a Lien could be filed; and (ii) all payrolls, material and equipment bills, and other indebtedness connected with the Work for which Owner or Owner's property might in any way be responsible have been paid or otherwise satisfied. If any Subcontractor or Supplier fails to furnish such a release or receipt in full, Contractor may furnish a bond or other collateral satisfactory to Owner to indemnify Owner against any Lien.

##### B. *Engineer's Review of Application and Acceptance*

1. 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 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 ten days after receipt of the final Application for Payment, indicate in writing Engineer's recommendation of payment and present the Application for Payment to Owner for payment. At the same time Engineer will also give written notice to Owner and Contractor that the Work is acceptable subject to the provisions of Paragraph 14.09. Otherwise, Engineer will return the Application for Payment 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 for Payment.

##### C. Payment Becomes Due

1. Thirty days after the presentation to Owner of the Application for Payment and accompanying documentation, the amount recommended by Engineer, less any sum Owner is entitled to set off against Engineer's recommendation, including but not limited to liquidated damages, will become due and , will be paid by Owner to Contractor.

#### 14.08 *Final Completion Delayed*

A. If, through no fault of Contractor, final completion of the Work is significantly delayed, and if

Engineer so confirms, Owner shall, upon receipt of Contractor's final Application for Payment (for Work fully completed and accepted) and recommendation of Engineer, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed and accepted. If the remaining balance to be held by Owner for Work not fully completed or corrected is less than the retainage stipulated in the Agreement, and if bonds have been furnished as required in Paragraph 5.01, the written consent of the surety to the payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by Contractor to Engineer with the Application for such payment. Such payment shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

#### 14.09 *Waiver of Claims*

A. The making and acceptance of final payment will constitute:

1. a waiver of all Claims by Owner against Contractor, except Claims arising from unsettled Liens, from defective Work appearing after final inspection pursuant to Paragraph 14.06, from failure to comply with the Contract Documents or the terms of any special guarantees specified therein, or from Contractor's continuing obligations under the Contract Documents; and

2. a waiver of all Claims by Contractor against Owner other than those previously made in accordance with the requirements herein and expressly acknowledged by Owner in writing as still unsettled.

### ARTICLE 15 - SUSPENSION OF WORK AND TERMINATION

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#### 15.01 *Owner May Suspend Work*

A. At any time and without cause, Owner may suspend the Work or any portion thereof for a period of not more than 90 consecutive 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 granted an adjustment in the Contract Price or an extension of the Contract Times, or both, directly attributable to any such suspension if Contractor makes a Claim therefor as provided in Paragraph 10.05.

#### 15.02 *Owner May Terminate for Cause*

A. The occurrence of any one or more of the following events will justify termination for cause:

1. Contractor's persistent failure 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 2.07 as adjusted from time to time pursuant to Paragraph 6.04);

2. Contractor's disregard of Laws or Regulations of any public body having jurisdiction;

3. Contractor's disregard of the authority of Engineer; or

4. Contractor's violation in any substantial way of any provisions of the Contract Documents.

B. If one or more of the events identified in Paragraph 15.02.A occur, Owner may, after giving Contractor (and surety ) seven days written notice of its intent to terminate the services of Contractor:

1. 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),

2. 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

3. complete the Work as Owner may deem expedient.

C. If Owner proceeds as provided in Paragraph 15.02.B, Contractor shall not be entitled to receive any further payment until the Work is completed. If the unpaid balance of the Contract Price exceeds all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) sustained by Owner arising out of or relating to completing the Work, such excess will be paid to Contractor. If such claims, costs, losses, and damages exceed such unpaid balance, Contractor shall pay the difference to Owner. Such claims, costs, losses, and damages incurred by Owner will be reviewed by Engineer as to their reasonableness and, when so approved by Engineer, incorporated in a Change Order. When exercising any rights or remedies under this Paragraph Owner shall not be required to obtain the lowest price for the Work performed.

D. Notwithstanding Paragraphs 15.02.B and 15.02.C, Contractor's services will not be terminated if Contractor begins within seven days of receipt of notice of intent to terminate to correct its failure to perform and proceeds diligently to cure such failure within no more than 30 days of receipt of said notice.

E. 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.

F. If and to the extent that Contractor has provided a performance bond under the provisions of Paragraph 5.01.A, the termination procedures of that bond shall supersede the provisions of Paragraphs 15.02.B, and 15.02.C.

#### 15.03 *Owner May Terminate For Convenience*

A. Upon seven days written notice to Contractor and Engineer, Owner may, without cause and without prejudice to any other right or remedy of Owner, terminate the Contract. In such case, Contractor shall be paid for (without duplication of any items):

1. 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;

2. 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;

3. all claims, costs, losses, and damages (including but not limited to all fees and charges of engineers, architects, attorneys, and other professionals and all court or arbitration or other dispute resolution costs) incurred in settlement of terminated contracts with Subcontractors, Suppliers, and others; and

4. reasonable expenses directly attributable to termination.

B. Contractor shall not be paid on account of loss of anticipated profits or revenue or other economic loss arising out of or resulting from such termination.

#### 15.04 *Contractor May Stop Work or Terminate*

A. If, through no act or fault of Contractor, (i) the Work is suspended for more than 90 consecutive days by Owner or under an order of court or other public authority, or (ii) Engineer fails to act on any Application for Payment within 30 days after it is submitted, or (iii) Owner fails for 30 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 Contract and recover from Owner payment on the same terms as provided in Paragraph 15.03.

B. In lieu of terminating the Contract and without prejudice to any other right or remedy, if Engineer has failed to act on an Application for Payment within 30 days after it is submitted, or Owner has failed for 30 days to pay Contractor any sum finally determined to be due, Contractor may, seven days after written notice to Owner and Engineer, stop the Work until payment is made of all such amounts due Contractor, including interest thereon. The provisions of this Paragraph 15.04 are not intended to preclude Contractor from making a Claim under Paragraph 10.05 for an adjustment in Contract Price or Contract Times or otherwise for expenses or damage directly attributable to Contractor's stopping the Work as permitted by this Paragraph.

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### ARTICLE 16 - DISPUTE RESOLUTION

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#### 16.01 *Methods and Procedures*

A. Either Owner or Contractor may request mediation of any Claim submitted to Engineer for a decision under Paragraph 10.05 before such decision becomes final and binding. The mediation will be governed by the Construction Industry Mediation Rules of the American Arbitration Association in effect as of the Effective Date of the Agreement. The request for mediation shall be submitted in writing to the American Arbitration Association and the other party to the Contract. Timely submission of the request shall stay the effect of Paragraph 10.05.E.

B. Owner and Contractor shall participate in the mediation process in good faith. The process shall be concluded within 60 days of filing of the request. The date of termination of the mediation shall be determined by application of the mediation rules referenced above.

C. If the Claim is not resolved by mediation, Engineer's action under Paragraph 10.05.C or a denial pursuant to Paragraphs 10.05.C.3 or 10.05.D shall become final and binding 30 days after termination of the mediation unless, within that time period, Owner or Contractor:

1. elects in writing to invoke any dispute resolution process provided for in the Supplementary Conditions, or

2. agrees with the other party to submit the Claim to another dispute resolution process, or

3. gives written notice to the other party of their intent to submit the Claim to a court of competent jurisdiction.



17.01 *Giving Notice*

A. Whenever any provision of the Contract Documents requires the giving of written notice, it will be deemed to have been validly given if:

1. 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

2. delivered at or sent by registered or certified mail, postage prepaid, to the last business address known to the giver of the notice.

17.02 *Computation of Times*

A. 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.

17.03 *Cumulative Remedies*

A. The duties and obligations imposed by these General Conditions and the rights and remedies available

hereunder to the parties hereto are in addition to, and 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. 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.

17.04 *Survival of Obligations*

A. All representations, indemnifications, warranties, and guarantees made in, required by, or given in accordance with the Contract Documents, as well as all continuing obligations indicated in the Contract Documents, will survive final payment, completion, and acceptance of the Work or termination or completion of the Contract or termination of the services of Contractor.

17.05 *Controlling Law*

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

17.06 *Headings*

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

**SECTION 00715  
LOCAL LABOR GOAL**

Estimated manhours of proposed workforce with a legal address  
**outside** 30 miles radius of The City of Greenup, Kentucky: \_\_\_\_\_%

Estimated manhours of proposed workforce with a legal address  
**inside** 30 miles radius of The City of Greenup, Kentucky: \_\_\_\_\_%

Contractor agrees to submit payroll records for review by The City of Greenup personnel.

\_\_\_\_\_  
Contractor Name

\_\_\_\_\_  
Company Representative Name/Title Printed

\_\_\_\_\_  
Company Representative Signature

\_\_\_\_\_  
Date

END OF SECTION 00715

SECTION 00820

SPECIAL CONDITIONS

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1. BID ON COMPLETE CONTRACTS

Bidders are required to make proposals on any one contract complete, but it is not necessary for a contractor to bid on more than one contract, unless specifically called for. In cases where a CONTRACTOR submits proposals for more than one contract, it shall be understood that the OWNER reserves the right to consider the proposal on each contract separately or in combination, in accordance with the method of bidding.

2. MODIFICATIONS OF BID

A Bidder may modify his Bid by an appropriate document duly executed (in the manner that a Bid must be executed) and delivered in a sealed envelope to the place where Bids are to be submitted at anytime prior to the scheduled time for opening of Bids. Facsimile machine transmittal of a request for modification of a Bid is not acceptable. The modification must not reveal the bid price, but shall provide the subtraction or addition, or other modifications, so that the final prices or terms will not be known to the OWNER until sealed bid is opened.

3. WITHDRAWAL OF BIDS

In addition to the information contained in the INSTRUCTIONS TO BIDDERS regarding the withdrawal of Bids, add the following:

"Bids may be withdrawn by an appropriate document duly executed and delivered (in the manner specified for Bid submittal) at any time prior to the opening of Bids. Facsimile machine transmittal for withdrawal of Bids is not acceptable.

4. INTERPRETATION OF CONTRACT DOCUMENTS

If any person contemplating the submission of a bid for the proposed contract is in doubt as to the true meaning of any part of the plans, specifications or other proposed contract documents, he should submit a written request for the interpretation thereof to Howerton Engineering and Surveying PLLC. The request must be received at least five days prior to the date fixed for the opening of bids. Any interpretation of the contract documents will be made only by addenda duly issued to each person receiving a set of such documents. The OWNER will not be responsible for explanations or interpretations of proposed documents, except as issued in accordance herewith.

5. ADDENDA

Any addenda or instruction to bidders issued prior to the time of opening bids shall be included as a requirement of the proposal. In closing the contract, they shall become a part thereof. Failure of any bidder to receive any such addendum or instruction to bidders shall not relieve such bidder from any obligation under his bid as submitted. All addenda so issued shall become part of the contract documents.

6. DISCREPANCY IN BID PRICE

In case of discrepancy between the bid price in words and in figures in the proposal, the price in words will control. In case of unit price bids, the unit price will control instead of the extension.

7. QUANTITIES, APPROXIMATE ONLY

Quantities listed on bid forms for unit price items are approximate only, and are not necessarily final quantities; however, they will be used in comparing bids. In actual construction, the estimated quantities may be reduced or increased without incurring obligation to the OWNER other than the amounts produced by the actual quantities installed at the unit price bid.

8. UNIT PRICES ON LUMP SUM CONTRACTS

The OWNER reserves the right to reject any or all of the unit prices for extra work set forth in the Form of Proposal for lump sum contracts, in the event that such prices are considered excessive or unreasonable, in which case the award of the contract will be contingent upon successful negotiation of prices for the unit price items.

9. THE METHOD OF BIDDING

The work under this Contract shall be bid by unit price and/or lump sum items as specified and shown in the Form of Proposal.

The base bid shall be for material indicated on the proposal. If a form for bidding alternate materials is included in the proposal, the CONTRACTOR shall completely fill in this form. The OWNER reserves the right to use any alternates or substitute items included on the bid form in the award of contracts.

The Contract shall be bid in full on the Form of Proposal

provided.

The OWNER reserves the right, should financing consideration require or allow, to delete or add physical units onto any unit price or lump sum items up to the limit that the total of their unit price extensions, in monetary value, does not exceed twenty-five percent (25%) of the bid for the whole contract.

#### 10. LABOR REGULATIONS AND MINIMUM WAGE RATES

Special attention is directed to Section 00830 - Labor Standards and Wage Rates. All contractors and subcontractors on the work shall be required to comply with all applicable provisions of the standards.

The CONTRACTOR shall be required to pay not less than the minimum wage rates as and if set forth in Section 00830 - Wage Rates, of these specifications or in an addendum to the specifications. The stipulated wage rates represent prevailing minimum rates and shall not be construed to mean that the CONTRACTOR may not have to pay higher rates to secure labor.

#### 11. AWARD OF CONTRACT

- a. The award of the Contract is contingent upon securing an accept able bid which will fall within the amount of funds available for the construction of the project.
- b. Each Contract shall be awarded to the lowest responsible bidder as soon as practicable after the opening of bids. In determining the lowest responsible bidder, the following elements will be considered: If the bidder involved maintains a permanent place of business; if he has adequate plant equipment to perform the work properly and expeditiously; if he has a suitable financial status to meet obligations incidental to the work; if he has appropriate technical experience; and, if he has a satisfactory performance bond.
- c. Any or all bids may be rejected or informalities in bids may be waived, at the option of the OWNER.
- d. The low bidder will be selected on the basis of the lowest Total Base Bid.
- e. The bid of the CONTRACTOR will not be considered for award if:

- (1) The bid is qualified in a manner deemed by the OWNER and/or the ENGINEER as unfair to other bidders.
- (2) The bid is so qualified as to reserve to the CONTRACTOR the right of acceptance or rejection after the bids are opened.
- (3) The bid is qualified in an ambiguous or a contradictory manner.

## 12. EXECUTION AND INTENT OF CONTRACT DOCUMENTS

Five (5) copies (or more if called for in the Contract Agreement - Section 00500) of the Contract Documents shall be signed by the OWNER and the CONTRACTOR. In case the OWNER and the CONTRACTOR fail to sign the General Conditions, Plans or Specifications, the ENGINEER shall identify them.

The Contract Documents are complementary, and what is called for by any one shall be as binding as if called for by all. The intention of the documents is to include all labor and materials, equipment and transportation necessary for the proper execution of the work.

Every Contract or surety bond, or other document guaranteeing performance of the Contract, shall provide that the document shall not be effective until it has been approved as to final execution by the OWNER.

## 13. PERFORMANCE AND PAYMENT BOND

The CONTRACTOR shall furnish a performance and payment bond (forms included in these specifications) issued by an approved bonding company in an amount at least equal to one hundred percent (100%) of the Contract price as security for the faithful performance of this Contract and for the payment of all persons performing labor and furnishing materials in connection with this Contract, to run for one (1) year from the date of final acceptance of the work, unless a longer period is specified. Attorneys-in-fact who sign bid bonds or contract bonds must file with each bond a certified copy of their power of attorney certificate. Such bonds and certificates must not be dated prior to the bid date or effective contract date and must be either signed or countersigned by a resident agent in the state where the Contract is to be bid or performed.

## 14. COPIES OF PLANS AND SPECIFICATIONS TO BE FURNISHED



Unless otherwise provided in the Special Conditions, the ENGINEER will furnish to the CONTRACTOR, free of charge, all copies of plans and specifications reasonably necessary for the execution of the work.

15. SAMPLES

The CONTRACTOR shall furnish for approval all samples as specified. The work shall be in accordance with approved samples.

16. MATERIALS AND EQUIPMENT

Unless otherwise specified, all materials shall be new and both workmanship and materials shall be of good quality. The CONTRACTOR shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

Approval of manufacturer's shop drawings of materials and equipment shall not mean final acceptance, but they shall be subject to inspection and test on delivery and installation. The CONTRACTOR shall repair, replace or adjust any materials or equipment found defective or not operating properly, due to improper materials, workmanship, and adjustment on his part, for a period of one year after completion and acceptance of his work.

The use of second hand and/or salvaged materials will not be permitted unless specifically provided for in the technical specifications. Materials and equipment shall be new when turned over to the OWNER.

17. MEASUREMENTS

All contractors furnishing materials and equipment for this Contract shall obtain exact dimensions at the site. Scale of figure dimensions on the drawings and details show the correct size under ideal conditions and shall not under any circumstances, be so construed as to relieve the CONTRACTOR from responsibility for taking measurements at the site and furnishing materials or equipment of the correct size.

18. SPECIFIC BRANDS, MAKES OR MANUFACTURER

Where a specific manufacturer or equipment is specified as being the base bid item, the CONTRACTOR must use the price installed of that manufacturer's item in compiling his base bid. In addition, he will show his installed price of this base bid item in the Listing of Major Equipment Items appended to the Form of

Proposal, opposite the named manufacturer for the specified equipment described therein. Where more than one manufacturer is listed in the specifications as being suppliers of a particular make of equipment, such manufacturer will be listed under the above mentioned Major Equipment Items Listing, and bidding contractors are encouraged to bid such listed manufacturer's offering. In such case, the installed price of this manufacturer's offering will be shown in the Major Equipment Items Listing, opposite the manufacturer's name for the specific item. Products of manufacturers other than those listed will be considered, provided their names are written in by the bidding contractor and he shows the installed price thereof in the same manner as for the named manufacturers.

Where specific brands, makes or manufacturers are named in the specifications or on the plans without the "or equal" clause, and none are specified as being the base bid item, the base bid shall be based only on the one or more named brands, makes or manufacturer. In such cases, the bidder will have the right to state along with the installed base bid price an additional substitute bid or bids on any other one or more brands, makes or manufacturers he may choose, provided he names such manufacturer(s) and understands that such bids will be considered as substitutes and it shall be the OWNER's option as to acceptance or rejection of such substitute bid or bids.

The CONTRACTOR will be responsible for and shall include in such substitute bid the cost of any redesign and/or construction cost necessary for fitting in the substitute equipment. He shall also be held responsible for the conformance of all such substitute bid equipment with the provision of the plans and specifications, and the acceptance of such equipment by the OWNER shall in no manner affect the CONTRACTOR's guarantee.

Only major equipment listed and quoted on the Form of Proposal (and for which the technical data, performance curves, descriptive material, major dimensions, etc., as required by the detailed specifications, is submitted in two copies, with the bid) will be considered in the final determination of the equipment to be furnished and installed.

#### 19. PROTECTION OF PUBLIC, WORKMEN, WORK AND PROPERTY

The CONTRACTOR shall continuously maintain adequate protection of all his work from damage and shall protect the OWNER's property from injury or loss arising in connection with this Contract. He shall make good any such damage, injury or loss, except such as

may be directly due to errors in the Contract Documents or caused by agents or employees of the OWNER. This shall not include completed portions of work taken over by OWNER for use and operation, where protection is the responsibility of the OWNER's operating forces and where the damage was not caused by the CONTRACTOR's operation on this or other portions of the work but only by lack of protection on the part of the OWNER's forces. He shall also adequately protect adjacent property as provided by law and the Contract Documents.

The CONTRACTOR shall take all necessary precautions for the safety of the public and employees and others engaged on the work and shall comply with all applicable provisions of Federal, State and Municipal safety laws, traffic regulations and building codes, to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. He shall erect and properly maintain at all times, as required by the conditions and progress of the work, all necessary safeguards for the protection of workmen, survey parties and the public, and shall post danger signs at proper places warning against the hazards created by such features of construction as survey instruments, ditches, protruding nails, hod hoists, well holes, elevator hatchways, scaffolding, window openings, stairways and falling materials, machinery, equipment and other hazards. Barricades and signs shall be kept clearly painted with applicable designations. All barricades, holes and obstructions shall be illuminated from sunset to sunrise.

20. CLAIMS FOR EXTRA COST

If the CONTRACTOR claims that any instructions by drawings or otherwise involved extra cost under this Contract, he shall give the OWNER written notice thereof within a reasonable time after the receipt of such instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property, and the procedure shall then be as provided for in the article entitled "CHANGES IN THE WORK" (00700). No such claim shall be valid unless so made.

21. DEDUCTIONS FOR UNCOMPLETED AND/OR UNCORRECTED WORK

When portions of unit price items have not been completed, such as testing, sterilizing, clean-up, and/or corrections, amounts desired appropriate by the Engineer shall be deducted from said items.

If the ENGINEER and the OWNER deem it inexpedient to correct work injured or not done in accordance with the Contract, an equitable

deduction from the contract price shall be made therefor.

22. CORRECTION OF WORK BEFORE FINAL PAYMENT

The CONTRACTOR shall promptly remove from the premises all materials and work condemned by the OWNER and/or ENGINEER as failing to conform to the Contract.

If the CONTRACTOR does not remove such condemned work and materials within a reasonable time, fixed by written notice, the OWNER may remove them and may store the material at the expense of the CONTRACTOR. If the CONTRACTOR does not pay the expenses of such removal within ten (10) days time thereafter, the OWNER may, upon ten (10) days written notice, sell such materials at auction or at private sale and shall account for the net proceeds thereof after deducting all the costs and expense that should have been borne by the CONTRACTOR.

23. CORRECTION OF WORK AFTER FINAL PAYMENT

Neither the final certificate, nor payment, nor any provisions in the Contract Documents shall relieve the CONTRACTOR of responsibility for faulty materials or workmanship and, unless otherwise specified, he shall remedy any defects due thereto and pay for any damage to other work resulting there from, which shall appear within a period of one (1) year from the date of final acceptance of the work by the OWNER. The OWNER shall give notice of observed defects with reasonable promptness. If replacements are not made within ten (10) days after notice is given of such defects in workmanship, or thirty (30) days in case of materials, then the OWNER shall have the right to make replacements and charge cost of same to the CONTRACTOR or his bondsman.

24. THE OWNER'S RIGHT TO DO WORK

If the CONTRACTOR should neglect to prosecute the work properly or fail to perform any provision of this Contract, the OWNER, in accordance with the General Conditions, after ten (10) days written notice to the CONTRACTOR, may without prejudice to any other remedy he may have, make good such deficiencies and may deduct the cost thereof from the payment then or thereafter due the CONTRACTOR.

25. STORED MATERIALS IN APPLICATION FOR PAYMENT

Only durable materials distributed out on site of work and other material and equipment properly stored and protected of over \$300 in cost shall be included in materials furnished in partial

payment estimates.

If materials and equipment delivered (stored or incorporated in work) and ninety percent (90%) paid for by the OWNER to CONTRACTOR on previous partial payment estimates are not paid for by the CONTRACTOR up to an equal amount, the sum not paid may be deducted from the amount due on a subsequent payment estimate.

26. CERTIFICATES OF PAYMENT

No certificate of payment issued nor payment made to the CONTRACTOR, nor partial or entire use or occupancy of the work by the OWNER, shall be an acceptance of any work or materials not in accordance with this Contract and shall not release the CONTRACTOR or his Sureties from any obligations under this Contract or the Performance and Payment Bond. The making and acceptance of the final payment shall constitute a waiver of all claims by the OWNER, other than those arising from unsettled liens, from faulty work appearing after final payment or from requirements of the plans and specifications.

The acceptance by the CONTRACTOR of final payment shall be and shall operate as a release to the OWNER of all claims and all liability to the CONTRACTOR for all things done or furnished in connection with this work or for any act and neglect of the OWNER and others relating to or arising from this work.

27. PAYMENTS WITHHELD AND APPLICATION TO OBLIGATIONS

Should the CONTRACTOR fail to pay or have waived all obligations and lawful claims of the nature hereinabove designated, then the OWNER may, after having served notice on the said CONTRACTOR, pay unpaid obligations and lawful claims of which the OWNER has written notice. The provisions of this sentence shall not be construed to impose any obligations upon the OWNER to either the CONTRACTOR or his Surety. In paying any unpaid bills of the CONTRACTOR, the OWNER shall be deemed the agent of the CONTRACTOR, and any payment so made by the OWNER, shall be considered as a payment made under the Contract by the OWNER to the CONTRACTOR and the OWNER shall not be liable to the CONTRACTOR for any such payment made in good faith.

28. USE OF COMPLETED PORTIONS

The OWNER shall have the right to take possession of and use any completed or partially completed portions that constitute separately functioning and useable parts of the work, notwithstanding that the time for completing the entire work, or

such portions, may not have expired; but such taking possession and use shall not be deemed an acceptance of any work not completed in accordance with the Contract Documents. If such prior use increases the cost of, or delays the work, the CONTRACTOR shall be entitled to such extra compensation, or extension of time, or both.

Insurance carrier shall be informed by the CONTRACTOR of occupancy and adjustments made so that coverage of construction will not be invalidated.

## 29. INSURANCE

The CONTRACTOR shall provide and include in his bid, the cost of all insurance required by these specifications. See Section 00700 regarding insurance coverage to be furnished by the CONTRACTOR under this Contract.

The CONTRACTOR shall not commence work under this Contract until he has obtained all insurance required, and such insurance has been approved by the OWNER, nor shall the CONTRACTOR allow any subcontractor to commence work on his subcontract until all similar insurance required of the subcontractor has been so obtained and approved.

All policies written for and applicable to the Contract of which this specification is a part shall provide for a minimum of ten (10) days written cancellation notice with notice to be given both to the OWNER and the ENGINEER. All policies must be signed or countersigned by a Resident Agent.

The following minimum coverage is required and shall be shown on the CONTRACTOR's Insurance Certificate. It shall be furnished by the CONTRACTOR for the benefit of the OWNER, ENGINEER, CONTRACTOR and subcontractors as their interests may appear:

(a) Worker's Compensation ..... Statutory  
Employer's Liability ..... \$100,000

(b) Comprehensive General Liability Including Coverage for Explosion, Collapse and Underground Hazards, Contractual Liability Products, and/or Completed Operations, Personal Injury (Employment Exclusion Waived), Broad Form Property Damage (No Deductible Clauses are Acceptable for These Coverages), and Independent Contractors (Subcontractors)

(1) Bodily Injury Liability .....\$500,000 ea.  
occurrence and in the aggregate

- (2) Personal Injury Liability .....\$500,000 ea. occurrence and in the aggregate
- (3) Property Damage Liability .....\$200,000 ea. occurrence and in the aggregate
- (4) Blasting Liability .....\$ 50,000 ea. occurrence (if applicable)
- (c) Commercial General Liability-Occurrence not less than \$2,000,000 General Aggregate, \$2,000,000 Products & Completed Aggregate, \$1,000,000 Personal & Advertising, \$1,000,000 each occurrence.
- (d) Automobile Liability: \$1,000,000.
- (e) Contractor's Public Liability Insurance not less than \$100,000.00 for damages arising out of bodily injuries to or death to one person. Not less than \$300,000.00 for damages arising out of bodily injuries to or death to two or more persons.
- (f) Contractor's Protective Public Liability and Property Damage Insurance. The contractor shall furnish evidence with respect to operations performed for him by subcontractors that he carries in his own behalf for the stipulated amounts

WORKMEN'S COMPENSATION INSURANCE. ASSURANCE OF WORKERS  
COMPENSATION INSURANCE AND UNEMPLOYMENT INSURANCE

The successful Contractor will be required to assure, by affidavit, that all Contractors and Sub-contractors employed, or will be employed, under the provisions of the contract shall be in compliance with Kentucky requirements for Worker's Compensation Insurance according to KRS Chapter 342 and Unemployment Insurance according to KRS Chapter 341.

The CONTRACTOR's certificate of insurance shall specifically indicate each applicable coverage which is provided under the policy. Certificates which merely indicate "Comprehensive Form" coverage shall not be acceptable.

In the event the CONTRACTOR does not provide evidence of blasting liability coverage on the certificate of insurance initially submitted in compliance with the specification, he shall not perform any blasting until he has submitted acceptable evidence of blasting coverage, in the form of either:

- (a) a certificate of insurance in the contractor's name, or
- (b) a certificate of insurance in the blasting contractor's

name, with the contractor named as "Additional Insured".

(c) Comprehensive Automobile Liability, Including Hired Care and Employer's Non-Ownership Liability Coverage

(1) Bodily Injury Liability .....\$500,000 ea.  
occurrence and in the aggregate

(2) Property Damage Liability .....\$200,000 ea.  
occurrence and in the aggregate

(d) All Risk Type Builder's Risk or Installation Floater  
.....100% of Contract Price

(e) Railroad Protective Insurance

(1) Bodily Injury .....(as required by  
railroad, if applicable)

(2) Property Damage .....(as required by  
railroad, if applicable)

(f) Umbrella Excess Liability .....\$1,000,000 Per  
Occurrence (with no aggregate except products completed  
operations)

(g) Flood Insurance .....Insurable Amount (when  
required)

(h) Owner's Protective Liability

The CONTRACTOR shall furnish a separate OWNER's Protective  
Liability policy, with no deductible amount, naming the  
Owner as Insured, in the following amounts:

(1) Bodily Injury Liability .....\$500,000 ea.  
occurrence  
and in the aggregate

(2) Personal Injury Liability .....\$500,000 ea.  
occurrence  
and in the aggregate

(3) Property Damage Liability .....\$500,000 ea.  
occurrence  
and in the aggregate

If there are conflicts between the Insurance requirements of the  
Special Conditions and the Insurance requirements in Section



00700 of these specifications, the Article with the greater limits of liability shall apply.

30. LIENS

Neither the final payment nor any part of the retained percentage shall become due until the CONTRACTOR, if required, shall deliver to the OWNER a complete release of all liens arising out of this Contract, or receipts in full in lieu thereof and, if required in either case, an affidavit that so far as he has knowledge, or information, the releases and receipts include all the labor and material for which a lien could be filed; but the CONTRACTOR may, if any subcontractor refuses to furnish a release or receipt in full, furnish a bond satisfactory to the OWNER, to indemnify him against any lien. If any lien remains unsatisfied after all payments are made, the CONTRACTOR shall refund to the Owner all moneys that the latter may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

31. SUBCONTRACTORS

The CONTRACTOR shall, at the time he submits his proposal for the Contract, notify the OWNER in writing of the names of subcontractors proposed for the work, and shall not employ any subcontractor without the prior written approval of the OWNER.

The CONTRACTOR agrees that he is as fully responsible to the OWNER for the acts and omissions of his subcontractors and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.

Nothing contained in the Contract Documents shall create any contractual relation between any subcontractor and the OWNER.

No part of this Contract shall be sublet without the prior written approval of the OWNER or his duly authorized representative.

32. RELATIONS OF CONTRACTOR AND SUBCONTRACTOR

The CONTRACTOR agrees to bind every subcontractor, and every subcontractor agrees to be bound by the terms of the Agreement, the General Conditions, the Plans and Specifications as far as applicable to his work, including the following provision of this article, unless specifically noted to the contrary in a subcontract approved in writing as adequate by the OWNER or the ENGINEER.

This does not apply to minor subcontracts.

The subcontractor agrees:

- a. To be bound to the CONTRACTOR by the terms of the Agreement, General Conditions, Plans and Specifications, and to assume toward him all the obligations and responsibilities that he, by those documents, assumes toward the OWNER.
- b. To submit to the CONTRACTOR applications for payment in such reasonable time as to enable the CONTRACTOR to apply for payment as set forth in these Contract Documents.
- c. To make all claims for extras, for extensions of time and for damages for delays or otherwise, to the CONTRACTOR in the manner provided in the General Conditions for like claims by the CONTRACTOR upon the OWNER, except that the time for making claims for extra cost is one (1) week.

The CONTRACTOR agrees:

- d. To be bound to the subcontractor by all the obligations that the OWNER assumes to the CONTRACTOR under the Agreement, General Conditions, Plans and Specifications, and by all provisions thereof affording remedies and redress to the CONTRACTOR from the OWNER.
- e. To pay the subcontractor, upon the payment of certificate, if issued under the schedule of values described in these Contract Documents, the amount allowed to the CONTRACTOR on account of the subcontractor's work to the extent of the subcontractor's interest therein.
- f. To pay the subcontractor, upon the payment of certificates, if issued otherwise than is in (e), so that at all times his total payments shall be as large in proportion to the value of the work done by him as the total amount certified to the CONTRACTOR is to the value of the work done by him.
- g. To pay the subcontractor to such extent as may be provided by the Contract Documents or the subcontract, if either of these provides for earlier or larger payments than the above.
- h. To pay the subcontractor on demand for his work or materials as far as executed and fixed in place, less the retain age percentage, at the time the certificate should be issued, even though the ENGINEER fails to issue if for any cause not

the fault of the CONTRACTOR.

- I. To pay the subcontractor a just share of any insurance money received by him, the CONTRACTOR, under these Contract Documents.
- j. To make no demand for liquidated damages or penalty for delay in any sum in excess of such amount as may be specifically named in the subcontract.
- k. That no claim for services rendered, or materials furnished by the CONTRACTOR to the subcontractor, shall be valid unless written notice thereof is given by the CONTRACTOR to the subcontractor during the first ten (10) days of the calendar month following that in which the claim originated.
- l. To give the subcontractor any opportunity to be present and submit evidence in any arbitration involving his rights.
- m. To name as arbitrator, under arbitration proceedings as provided in the Contract Documents the person nominated by the subcontractor, if the sole cause of dispute is the work, materials, rights or responsibilities of the subcontractor; or, if of the subcontractor and any other subcontractor jointly, to name as such arbitrator the person upon whom they agree.

The CONTRACTOR and subcontractor agree that:

- n. In the matter of arbitration, their rights and obligations and all procedure shall be analogous to those set forth in this Contract.  
Nothing in this article shall create any obligation on the part of the OWNER to pay or see to payment of any sums to any subcontractor.

### 33. USE OF PREMISES

The CONTRACTOR shall confine his apparatus, the storage of materials and the operations of his workmen to limits indicated by law, ordinances, permits or directions of the OWNER and shall not unreasonably encumber the premises with his materials.

### 34. CLEANING UP

The CONTRACTOR shall at all times keep the premises free from accumulations of waste material, rubbish, weeds, brush or other debris caused by his employees or the work. At the completion of

the work, the CONTRACTOR shall remove all waste materials, rubbish and debris from and about the premises, as well as all tools, scaffolding, construction equipment, machinery and surplus materials, and shall leave the site in a clean and usable condition, satisfactory to the OWNER, unless more exactly specified. In case of dispute, the OWNER may remove the debris and charge the cost to the CONTRACTOR(s).

The CONTRACTOR shall direct his forces to clean up streets, sidewalks, drainage channels, or private property affected by his construction operations, when, the OWNER judges that such clean up is needed.

The Contract shall not be considered complete until all construction structures, equipment, waste materials, rubbish and debris resulting from the construction are cleaned from the site of the work. All damage to existing paving, grounds, and structures caused by the CONTRACTOR's operation must be repaired or the OWNER compensated for such damage before the Contract will be considered complete.

#### 35. POINTS AND INSTRUCTIONS

The CONTRACTOR shall provide reasonable and necessary opportunities and facilities for setting points and making measurements. He shall not proceed until he has received such points and instructions as may be necessary as the work progresses. The work shall be done in strict conformity with such points and instructions.

#### 36. "OR EQUAL" CLAUSE

Wherever the words "or equal" appear in the specifications or on the plans, they shall be interpreted to mean an item of material or equipment equal in quality to that named and which is suited to the same use and capable of performing the same function as that named.

The burden of proof of equal quality or service shall be on the CONTRACTOR. Proof of inequality is not implied by the specifications, and is not a burden of the ENGINEER. His duty shall be to properly weigh the facts of equality in fairness to all parties involved.

Inclusion of a certain make or type of materials or equipment in the CONTRACTOR's bid or estimate shall not obligate the OWNER to accept such material or equipment if it does not meet the requirements of the plans and specifications.

37. THE ENGINEER

Wherever in these Contract Documents reference is made to the ENGINEER, it shall be understood to mean the duly authorized representative of the OWNER, designated to act in a professional capacity, for the planning and execution of the work.

38. RESIDENT PROJECT REPRESENTATIVE

At all times that a Resident Project Representative is assigned to the construction project, he shall be the representative of the ENGINEER, as defined in this Contract, with the authority to delegate his functions to subordinate engineers and inspectors. Where correspondence is necessary to the ENGINEER's main office, the Resident Project Representative shall receive a copy and shall be kept fully informed of all CONTRACTOR's transactions with the main office, including status of submittal and approval of shop drawings.

39. CONTRACTOR'S UNDERSTANDING

It is understood and agreed that the CONTRACTOR has, by careful examination, satisfied himself as to the nature and location of the work, the conformation of the ground, quality and quantity of the materials to be encountered, the character of equipment and facilities needed preliminary to and during the prosecution of the work, the general and local conditions, and all other matters which can in any way affect the work under this Contract. No verbal agreement or conversation with any officer, agent or employee of the OWNER, either before or after the execution of this Contract, shall affect or modify any of the terms or obligations herein contained.

40. PERSONAL LIABILITY OF PUBLIC OFFICIALS

In carrying out any of the provisions of the Contract or in exercising any power or authority granted to him thereby, there shall be no personal liability upon the ENGINEER or the OWNER's other or employees, it being understood that in such matters they act as the agents and representatives of the OWNER.

41. WORK REASONABLY INFERRED, BUT NOT PARTICULARLY DELINEATED OR SPECIFIED

The CONTRACTOR shall make a thorough examination of the site and study all plans and specifications and all conditions relating to the erection of the work, and if any materials or labor are evidently necessary for the proper and complete execution of the

work, which are not specifically mentioned and included in the plans and specifications, although reasonably inferred there from, unless eliminated by special mention, or if any error or inconsistency appears therein, or in the event of a doubt arising as to the true intent and meaning of the plans and specifications, he shall notify the ENGINEER at least five (5) days in advance of date fixed for opening of bids. The ENGINEER will then issue an addendum containing the proper information to all contractors, to assure fair competition.

42. DISCREPANCIES

Anything called for in the specifications and not shown on the plans, or shown on the plans and not called for in the specifications, shall be included in the CONTRACTOR's work as if included in both.

In case of discrepancies between the various parts of the plans and the specifications, the detailed plans and specifications shall take precedence over the general plan layouts or elevations and general specifications. Detailed specifications shall take precedence over all other documents.

43. INSPECTION AND TESTING OF MATERIALS

Materials of construction, particularly those upon which the strength and durability of the structure may depend, shall be subject to inspection and testing to establish conformation with specifications and suitability for uses intended.

44. CARE OF THE WORK

The CONTRACTOR shall have full charge of the premises and work under construction until completion and final acceptance of the work under the Contract, except as noted otherwise in these Contract Documents.

The CONTRACTOR shall be responsible for all injury to work in process of construction, and for all property or materials stored on the premises that may be injured or stolen while the work is in his care and he shall make good all such damage or loss without expense to the OWNER, except as noted otherwise in these Contract Documents.

45. DAMAGE TO EQUIPMENT STORED AND/OR IN PLACE PRIOR TO INITIAL OPERATION

Any equipment damaged or which has been subjected to possible

damage by reason of inundation, improper storage and/or protection during the construction period of a project, shall be handled only as follows:

- a. Be replaced with new equipment.
- b. With approval of the OWNER, be returned to the manufacturer of the equipment, or his authorized repair agency, for inspection and repair, provided however, that such repair after inspection will place the equipment in new condition, and restore the manufacturer's guarantee the same as for new equipment.

This is particularly applicable to, but not limited to, electric motors, motor controls, meters and gauges, and equipment with bearings.

#### 46. SALVAGED MATERIALS AND EQUIPMENT

All materials and/or equipment to be removed from existing structures and not specifically specified to be re-used or stored shall be stored or removed for disposal as directed by the OWNER in the field. Re-used or stored material and/or equipment remain the property of the OWNER. Material and/or equipment not re-used or stored shall become the property of the CONTRACTOR. Such materials and/or equipment shall be promptly removed by the CONTRACTOR from the site for disposal by the CONTRACTOR.

#### 47. CONFLICT WITH OR DAMAGE TO EXISTING UTILITIES AND FACILITIES

Insofar as location data is available to the ENGINEERS, existing underground utilities (such as water lines, sewer lines, gas lines, telephone conduits, etc.) are accurately located on the Drawings. Due, however, to the approximate nature of much of this data, the location of any particular facility cannot be certified to be correct. In general, locations and elevations shown are approximate only.

Before proceeding with the work, the CONTRACTOR shall confer with all public or private companies, agencies or departments that own and operate utilities in the vicinity of the construction work. The purpose of the conference, or conferences, shall be to notify said companies, agencies, or departments of the proposed construction schedule, verify the location of, and possible interference with the existing utilities that are shown on the plans, arrange for necessary suspension of service, and make arrangements to locate and avoid interference with all utilities (including house connections) that are not shown on the plans.

The CONTRACTOR may make arrangements for the said utility companies, agencies or departments to locate and uncover their own utilities; however, the CONTRACTOR shall bear the entire responsibility for locating and avoiding or repairing damage to said existing utilities.

Repair to existing utilities and facilities damaged by the CONTRACTOR's construction forces shall be considered as a part of the Contract covered only by the prices bid for the new construction. The only exceptions to this provision, wherein extra compensation will be authorized, are:

- a. Relocation of an existing facility due to direct conflict with the new pipe line.
- b. Relocation (outside of limits of maximum allowable trench widths) of an existing facility presently located within the bounds of maximum allowable trench width, where necessitated for assurance against future damage due to settlement or to permit reasonable access to the new work.
- c. Alteration in the new material of an existing utility in close proximity to a new pipe line.
- d. Extra cost of replacing or supporting and trenching under an existing facility or utility where its angle with the pipe line being installed is less than forty-five degrees, or parallel to and falling within the practical limits of a properly protected trench.

Repair to damaged underground utilities, whether reimbursable or otherwise, must meet the requirements of the agency in charge of that particular utility.

The intent of this article is to assure compensation to the CONTRACTOR for changes in existing utilities reasonably necessary, and at the same time, to protect the OWNER against excessive damages due to carelessness of the CONTRACTOR's construction forces.

Compensation for extra work covered herein shall be in accordance with other provisions of these Special Conditions.

Where the existing utilities must be disturbed during construction under this Contract, their operation and functions shall be maintained by the CONTRACTOR to such a degree that service to customers will be interrupted for minimum time periods only. Such disturbances and any maintenance use of these lines



shall constitute no cost to the OWNER. The OWNER shall be notified of interruptions in sufficient time to prepare for them, and shall agree to the hour, date and duration of them before they are undertaken. Where the existing utilities must be interrupted, CONTRACTOR shall have all materials to complete the work on the job site before the interruption begins. Should shut-downs in services be in excess of the time of duration agreed upon, and such excessive shut-down time be due to the CONTRACTOR's negligence, faulty work and/or inability to perform, then and in that event, the CONTRACTOR shall be held liable to the OWNER for any and all damages that may accrue to the OWNER, by reason of such excessive shut-down periods.

Upon damage to existing facilities, they shall be repaired immediately and tested to insure proper operation. CONTRACTOR shall notify all utility users of impending interruption of service and shall be responsible for all damages resulting from same. Payment for necessary disconnection and reconnection of utility services shall be included as part of the CONTRACTOR's bid and no extra compensation will be made for same.

#### 48. WORK ON PRIVATE PROPERTY

In work performed on "private property" (property other than that belonging to the OWNER), the CONTRACTOR shall confine his equipment, the storage of materials and the operation of his workmen to the limits indicated on the Drawings, or to lands and rights-of-way provided for the project by the OWNER, and shall take every precaution to avoid damage to the private property owner's buildings, grounds and facilities.

Fences, hedges, shrubs, etc. within the construction limits shall be carefully removed, reserved and replaced when the construction is completed. Where ditches or excavations cross lawns, the sod shall be removed carefully and replaced when the backfilling has been completed. If sod is damaged or not handled properly, it shall be replaced with new sod equal to existing sod at the CONTRACTOR's expense, unless otherwise specified. Grassed areas, other than lawns, shall be graded, fertilized and seeded when construction is completed and in accordance with the requirements of these specifications. When construction is completed, the private property owner's facilities and grounds shall be restored to as good or better condition than found as quickly as possible at the CONTRACTOR's expense.

Large trees or other facilities within the actual construction limits that cannot be preserved and replaced shall be removed by the CONTRACTOR but the OWNER will assume the responsibility for

settling with the property owner for the loss of said trees or facilities. Such trees and facilities, however, will be designated on the Drawings and the CONTRACTOR shall be solely and entirely responsible for any damage to trees or facilities not so designated.

Foundations, adjacent to where an excavation is to be made below the bottom of the foundation, shall be supported by shoring, bracing or underpinning as long as the excavation shall remain open, and the CONTRACTOR shall be held strictly responsible for any damage to said foundation.

Highway rights-of-way, railroad rights-of-way, public parks, school yards and other such properties shall be considered "private properties" for the purpose of this Article.

#### 49. COORDINATION BETWEEN CONTRACTORS

Wherever other work is simultaneously in progress under other contracts for construction at this site, all contractors performing work under these Contract Documents shall lay out their work and locate temporary buildings and equipment set-ups in such a manner as not to cause interference or delay to other work at the site of this construction. To this end, contractors shall confer with and secure written approval from the OWNER or his duly authorized representative for the location or any temporary structure or plant set-up. Such approval shall not relieve the CONTRACTOR from responsibility for interference with or delay to work of others.

#### 50. ACCESS TO THE WORK

The representatives of the supporting Federal agencies and the officials of state and local government shall have access to the work wherever it is in preparation or progress; and the CONTRACTOR shall provide proper facilities for such access and inspection when requested.

#### 51. CONCURRENCE OF PARTICIPATING FEDERAL AGENCIES

When an agency (or agencies) of the Federal Government is providing funds for the project, administrative procedures usually require their approval for contract award, interim financing procedures, subcontractors, contractor and subcontractor payrolls, contract change orders involving monetary changes or adjustment of completion dates, and final payment under the construction contract(s). Action by the OWNER without such approvals may be cause for withholding of funds by the

agency (agencies). It is, therefore, necessary for the CONTRACTOR to submit payroll records, requests for change orders and payment estimates as early and as completely as possible to insure that the OWNER may obtain agency approval before making payments therefore under the Contract.

## 52. LAWS AND REGULATIONS

The bidder's attention is directed to the fact that all applicable state laws, municipal ordinances and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the Contract throughout, and they will be deemed to be included in the Contract the same as though herein written out in full.

The CONTRACTOR shall abide by all local and state laws or ordinances to the extent that such regulations do not conflict with Federal laws or regulations. The law of the place of building shall govern the construction of this Contract.

## 53. CONSTRUCTION VIDEOTAPES

Videotapes are required on this project and are the responsibility of the CONTRACTOR. CONTRACTOR shall be responsible for the filming and labeling of the videotapes. All videotapes shall be identified as to location, date and subject matter. The following videotapes shall be taken:

1. Existing landscape before construction;
2. Landscape after cleanup.

The CONTRACTOR, before final payment is made, shall deliver all videotapes to the OWNER labeled as outlined above.

No pay item has been set up for the videotapes. The CONTRACTOR shall allow for a complete set of project videotapes in his bid.

## 54. SUBSURFACE CONDITIONS

54.1 The CONTRACTOR shall promptly, and before such conditions are disturbed, except in the event of an emergency, notify the OWNER by written notice of:

54.1.1 Subsurface or latent physical conditions at the site differing materially from those indicated in the Contract Documents.

54.1.2 Unknown physical conditions at the site, of an unusual nature, differing materially from

those ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents.

54.2 The ENGINEER shall promptly investigate and report to the OWNER the conditions represented by the CONTRACTOR to be materially different, as described in this Article, and if the OWNER finds that such conditions do so materially differ as to warrant an increase or decrease in the cost of, or in the time required for, performance of the work, an equitable adjustment shall be made and the Contract Documents shall be modified by a Change Order. Any claim of the CONTRACTOR for adjustment hereunder shall not be allowed unless the CONTRACTOR has given the required written notice.

55. PROTECTION OF VEGETATION

55.1 Reasonable care shall be taken during construction to avoid damage to vegetation. Ornamental shrubbery and tree branches shall be tied back, where appropriate, to minimize damage. Trees which receive damage to branches shall be trimmed of those branches to improve the appearance of the tree. Tree trunks receiving damage from equipment shall be treated with a tree dressing.

56. CHANGE ORDERS

56.1 All change orders to this contract shall be approved in writing by the engineer prior to construction activities.

57. ALLOWANCE FOR ADDITIONAL ITEMS  
REFER TO SECTION 01210 ALLOWANCES.

58. PROJECT SIGN  
N/A

# Work Change Directive

No. \_\_\_\_\_

Date of Issuance: \_\_\_\_\_ Effective Date: \_\_\_\_\_

Project:	Owner:	Owner's Contract No.:
Contract:	Date of Contract:	
Contractor:	Engineer's Project No.:	

**You are directed to proceed promptly with the following change(s):**

Item No.	Description

**Attachments (list documents supporting change):**


**Purpose for Work Change Directive:**

- ☐ Authorization for Work described herein to proceed on the basis of Cost of the Work due to:
- ☐ Nonagreement on pricing of proposed change.
- ☐ Necessity to expedite Work described herein prior to agreeing to changes on Contract Price and Contract Time.

**Estimated change in Contract Price and Contract Times:**

Contract Price \$ \_\_\_\_\_ (increase/decrease)      Contract Time \_\_\_\_\_ days (increase/decrease)

If the change involves an increase, the estimated amounts are not to be exceeded without further authorization.

Recommended for Approval by Engineer:	Date
Authorized for Owner by:	Date
Accepted for Contractor by:	Date
Approved by Funding Agency (if applicable):	Date:

# Change Order

No. \_\_\_\_\_

Date of Issuance: \_\_\_\_\_ Effective Date: \_\_\_\_\_

Project:	Owner:	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

## The Contract Documents are modified as follows upon execution of this Change Order:

Description:

Attachments: (List documents supporting change):

### CHANGE IN CONTRACT PRICE:

Original Contract Price:

\$ \_\_\_\_\_

[Increase] [Decrease] from previously approved Change Orders No. \_\_\_\_\_ to No. \_\_\_\_\_:

\$ \_\_\_\_\_

Contract Price prior to this Change Order:

\$ \_\_\_\_\_

[Increase] [Decrease] of this Change Order:

\$ \_\_\_\_\_

Contract Price incorporating this Change Order:

\$ \_\_\_\_\_

### CHANGE IN CONTRACT TIMES:

Original Contract Times: ☐ Working days ☐ Calendar days

Substantial completion (days or date): \_\_\_\_\_

Ready for final payment (days or date): \_\_\_\_\_

[Increase] [Decrease] from previously approved Change Orders No. \_\_\_\_\_ to No. \_\_\_\_\_:

Substantial completion (days): \_\_\_\_\_

Ready for final payment (days): \_\_\_\_\_

Contract Times prior to this Change Order:

Substantial completion (days or date): \_\_\_\_\_

Ready for final payment (days or date): \_\_\_\_\_

[Increase] [Decrease] of this Change Order:

Substantial completion (days or date): \_\_\_\_\_

Ready for final payment (days or date): \_\_\_\_\_

Contract Times with all approved Change Orders:

Substantial completion (days or date): \_\_\_\_\_

Ready for final payment (days or date): \_\_\_\_\_

RECOMMENDED:

By: \_\_\_\_\_  
Engineer (Authorized Signature)

Date: \_\_\_\_\_

Approved by Funding Agency (if applicable): \_\_\_\_\_

ACCEPTED:

By: \_\_\_\_\_  
Owner (Authorized Signature)

Date: \_\_\_\_\_

ACCEPTED:

By: \_\_\_\_\_  
Contractor (Authorized Signature)

Date: \_\_\_\_\_

Date: \_\_\_\_\_

# Change Order

## Instructions

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### **A. GENERAL INFORMATION**

This document was developed to provide a uniform format for handling contract changes that affect Contract Price or Contract Times. Changes that have been initiated by a Work Change Directive must be incorporated into a subsequent Change Order if they affect Price or Times.

Changes that affect Contract Price or Contract Times should be promptly covered by a Change Order. The practice of accumulating Change Orders to reduce the administrative burden may lead to unnecessary disputes.

If Milestones have been listed in the Agreement, any effect of a Change Order thereon should be addressed.

For supplemental instructions and minor changes not involving a change in the Contract Price or Contract Times, a Field Order should be used.

### **B. COMPLETING THE CHANGE ORDER FORM**

Engineer normally initiates the form, including a description of the changes involved and attachments based upon documents and proposals submitted by Contractor, or requests from Owner, or both.

Once Engineer has completed and signed the form, all copies should be sent to Owner or Contractor for approval, depending on whether the Change Order is a true order to the Contractor or the formalization of a negotiated agreement for a previously performed change. After approval by one contracting party, all copies should be sent to the other party for approval. Engineer should make distribution of executed copies after approval by both parties.

If a change only applies to price or to times, cross out the part of the tabulation that does not apply.

## Field Order

**No.** \_\_\_\_\_

Date of Issuance: \_\_\_\_\_ Effective Date: \_\_\_\_\_

Project:	Owner:	Owner's Contract No.:
Contract:		Date of Contract:
Contractor:		Engineer's Project No.:

**Attention:**

You are hereby directed to promptly execute this Field Order issued in accordance with General Conditions Paragraph 9.05A., for minor changes in the Work without changes in Contract Price or Contract Times. If you consider that a change in Contract Price or Contract Times is required, please notify the Engineer immediately and before proceeding with this Work.

Reference: \_\_\_\_\_  
(Specification Section(s)) (Drawing(s) / Detail(s))

Description:

Attachments:

Engineer:

Receipt Acknowledged by (Contractor):	Date:
---------------------------------------	-------

Copy to Owner



## SECTION 01010

### SUMMARY OF WORK

#### PART 1 GENERAL

##### 1.01 SCOPE OF WORK COVERED BY THE CONTRACT

- A. These specifications and the accompanying drawings describe the work to be done and the materials to be furnished for construction.

##### 1.02 RELATED REQUIREMENTS

- A. Refer to the Contract Agreement for an enumeration of the Contract Documents.
- B. Refer to Section 00820 for coordination with other CONTRACTORS.

##### 1.03 WORK SEQUENCE

- A. The information on sequencing given in this Section is intended to identify constraints with respect to keeping the existing distribution system in operation and to provide timely completion of the portion of the work. Nothing in this section shall be construed as relieving the CONTRACTOR from his responsibility to complete the work within the Contract time.

The CONTRACTORS should plan the work in order to facilitate the progress of the work with a minimum of interruption and/or "down-time" to the normal operating conditions of the water distribution system. The CONTRACTOR will, in all cases, coordinate his construction with the distribution superintendent and operating personnel. Operation of the distribution system will, in all cases, take precedence over the construction.

- B. The CONTRACTOR shall construct the lines in the following sequence:

Not applicable to this contract.

- C. Equipment Acceptance

As used herein, with respect to equipment, the word "operational" means constructed and installed, inspected, tested, operated by the CONTRACTOR for an adequate period, checked by the manufacturer's factory representative, a certificate provided by the manufacturer as required by this Division, Section 01600, and accepted for operation and maintenance by the OWNER. Operation by the CONTRACTOR for an adequate period is defined as a minimum of 5 days continuous operation without failure for each of the following units:

Not applicable to this contract.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01019

CONTRACT CONSIDERATION

PART 1 GENERAL

1.01 SUMMARY

- A. Work Included:
  - 1. Measurement and Payment - Unit Prices, for additional work awarded beyond lump sum bid.

1.02 MEASUREMENTS AND PAYMENT - UNIT PRICES

- A. Measurement methods are delineated in the individual Specification sections.
- B. CONTRACTOR shall take measurements and compute quantities. ENGINEER will check measurements and quantities.
- C. Incidental Items of Work: Any items of work shown on the drawings or called for in the specifications, but not included in the bid form, shall be considered incidental items of work. The cost of incidental items of work shall be included in the prices bid adjacent work.

PART 2 PRODUCTS

NOT APPLICABLE

PART 3 EXECUTION

NOT APPLICABLE

END OF SECTION

PART 1. GENERAL

1. REQUIREMENTS INCLUDED

- A. Procedures for preparation and submittal of Applications for Payment.

1.2 RELATED REQUIREMENTS

- A. Section 00515 - Owner-Contractor Agreement: Contract Sum and Unit Price (if applicable), Amounts of Progress Payments, Retainages, and times for submittals.
- B. Section 00713 - General Conditions: Progress Payments and Final Payment.
- C. Section 01300 - Submittals: Submittal procedures and schedule of values.
- D. Section 01700 - Contract Closeout: Final Payment.

1.3 FORMAT

- A. AIA Document G702 (or approved equal form) - Partial Payment Estimate.

1.4 PREPARATION OF APPLICATIONS

- A. Type required information or use media-driven printout with prior approval by the A/E.
- B. Execute certification by signature of authorized officer.
- C. Use data on accepted Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

- D. List each authorized Change Order as an extension on continuation sheet, listing Change Order number and dollar amount as for an original item of work.
- E. Prepare Application for Final Payment as specified in Section 01700.

#### 1.5 SUBMITTAL PROCEDURES

- A. Submit six (6) copies of each Application for Payment at times stipulated in Agreement.
- B. Submit under transmittal letter specified in Section 01300.

#### 1.6 SUBSTANTIATING DATA

- A. When A/E requires substantiating information, submit data justifying line item amounts in question.
- B. Provide one (1) copy of data with cover letter for each copy of submittal. Show Application number and date, and line item by number and description.

#### PART 2 PRODUCTS

NOT USED

#### PART 3 EXECUTION

NOT USED

END OF SECTION

PART 1. GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Procedures for processing Change Orders.

1.2 RELATED REQUIREMENTS

- A. Section 00515 - Agreement Forms: Monetary values of established Unit Prices, if applicable, and/or lump sum amounts.
- B. Section 00713 - General Conditions: Governing requirements for changes in the work, in Contract Cost, and Contract Time.
- C. Section 00815 - Supplementary Conditions: Percentage allowances for Contractor's overhead and profit.
- D. Section 01027 - Applications for Payment.
- E. Section 01300 - Submittals: Progress Schedules and Schedule of Values.
- F. Section 01600 - Material and Equipment and Substitutions: Substitutions
- G. Section 01700 - Contract Closeout: Project record documents.

1.3 SUBMITTALS

- A. Submit name of the individual authorized to accept changes, and to be responsible for informing others in Contractor's employ of changes in the work.
- B. Change Order Forms: AIA G701, or approved equal form.

1.4 DOCUMENTATION OF CHANGE IN CONTRACT SUM AND CONTRACT TIME

- A. Maintain detailed records of work done on a time and material basis.

Provide full information required for evaluation of proposed changes, and to substantiate costs of changes in the work.

- B. Document each quotation for a change in cost or time with sufficient data to allow evaluation of the quotation.
- C. On request, provide additional data to support computations:
  - 1. Quantities of itemized products, labor and equipment.
  - 2. Taxes, insurance and bonds.
  - 3. Overhead and profit.
  - 4. Justification for any change in Contract Time.
  - 5. Credit for deletions from Contract, similarly documented.
- D. Support each claim for additional costs, and for work done on a time and material basis, with additional information:
  - 1. Origin and date of claim.
  - 2. Dates and times work was performed, and by whom.
  - 3. Time records and wage rates paid.
  - 4. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

#### 1.5 PRELIMINARY PROCEDURES

- A. A/E may submit a Proposal request which includes: detailed description of change with supplementary or revised Drawings and Specifications, the projected time for executing the change, and the period of time during which the requested price will be considered valid.
- B. Contractor may initiate a change by submittal of a request to the A/E describing the proposed change with a statement of the reason for the change, and the effect on Contract Sum and Contract Time with full documentation, and a statement of the effect on work of separate contractors. Document any requested substitutions in accordance with Section 01600 of these contract documents.

#### 1.6 CONSTRUCTION CHANGE AUTHORIZATION

- A. A/E may issue a directive, signed by the Owner, instructing Contractor to proceed with a change in the work, for subsequent inclusion in a Change Order.
- B. Directive will describe changes in the work, and will designate method of determining any change in Contract Sum or Contract Time.

- C. Promptly executes the change in work.

#### 1.7 LUMP SUM CHANGE ORDER

- A. Will be based on Proposal Request and Contractor's lump sum quotation or Contractor's request for Change Order as approved by the A/E.

#### 1.8 UNIT PRICE CHANGE ORDER

- A. For pre-determined unit prices and quantities, Change Order will be executed on a fixed price basis.
- B. For unit costs or quantities of units of work which are not predetermined, execute work under a construction change authorization. Changes in Contract Sum or Contract Time will be computed as specified for time and material Change Order.

#### 1.9 TIME AND MATERIAL CHANGE ORDER

- A. Submit itemized account and supporting data after completion of change, within time limits in Conditions of the Contract.
- B. A/E will determine the change allowable in Contract Sum and Contract Time as provided in Conditions of the Contract.

#### 1.10 EXECUTION OF CHANGE ORDERS

- A. A/E will issue Change Orders for signatures of parties as provided in Conditions of the Contract.

#### 1.11 CORRELATION OF CONTRACTOR SUBMITTALS

- A. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum as shown on Change Order.
- B. Promptly revise Progress Schedules to reflect any change in Contract Time, revise sub-schedules to adjust times for other items of work affected by the change, and resubmit.
- C. Promptly enters changes in Project Record Documents.



PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

NOT USED

END OF SECTION

**1. ACCESS TO PROJECT**

The project shall be accessible at all times to representatives of the Department of Environment and Conservation, and any other state, local, or federal regulatory agencies. Project areas at existing utility crossings and federal interstate, state, county and city roadways shall be accessible to the utilities and road representatives at all times for inspection and coordination of applicable utility and road crossings.

**2. SMOKING AND FIRE PRECAUTIONS**

- 2.1 No smoking, fire or use of any fire or explosion-producing tools or equipment will be permitted on the properties of oil companies or other concerns prohibiting same on their premises or at any locations where such may endanger said premises or the current operations thereon.

**3. MANUFACTURERS' QUALIFICATIONS**

- 3.1 The manufacturers of all materials and equipment used must be reputable and regularly engaged in the manufacture of the particular material or equipment for the use and service to which it will be subjected.

**4. CONTRACTOR SHALL PAY FOR ALL LABORATORY INSPECTION SERVICE**

- 4.1 All materials and equipment used in the construction of the project shall be subject to adequate inspection and testing in accordance with accepted standards. The laboratory or inspection agency shall be selected by the Contractor and approved by the Owner and A/E. The Contractor shall pay for all laboratory inspection services as a part of the Contract. Submit all material test reports to the A/E in triplicate.

**5. COMPLIANCE WITH STATE AND LOCAL LAWS**

- 5.1 Comply with all applicable requirements of state and local laws and ordinances to the extent that such requirements do not conflict with federal laws or regulations.

## 6. PROTECTION OF PUBLIC AND PRIVATE PROPERTY

- 6.1 Take special care in working areas to protect public and private property. The Contractor shall replace or repair at his own expense any damaged water pipes, power and communication lines, fiber optic cables, natural gas lines, sewer lines, storm drainage lines and components, or other public utilities, county roads, curbs, gutters, sidewalks, drain pipes, drainage ditches, and all plantings, including grass or sod on the site of the work. Leave the site in original or better condition after all cleanup work has been done.

## 7. MARKERS

- 7.1 Preserve all Corps of Engineers, USGS, State and private markers; do not remove or disturb any such markers without prior approval the A/E. Any removal and replacement of such markers shall be at the expense of the Contractor.

## 8. PROJECT SIGNS

Furnish and erect one (1) project sign for each contract near the project at a location approved by the A/E. The sign shall be prepared in accordance with the attached description and as shown in Standard Drawing S-1.

- 8.1 The signboard shall be 8' x 4' 3/4" marine plywood painted white.
- 8.2 The lower edge of the board shall be 5'0" above grade. The sign must be supported as shown in the detail drawings.
- 8.3 In addition to the information shown on the standard drawing, the Contractor's name and address shall be painted on sign in block lettering of appropriate size with black paint.

## 9. PAVEMENT REPAIR AND/OR REPLACEMENT

- 9.1 Whenever pipe trenches are cut across or along existing pavement or shoulders, backfill to top with stone and restore traffic over the cuts as quickly as possible by constructing a temporary twelve-inch (12") surface of Class A, Grade D crushed stone. Add material and otherwise maintain such surface until the permanent pavement is restored or until the entire project is accepted. The pavement restoration shall be as directed by the state, county, and city road superintendents.

## 10. APPROVED CHEMICALS

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

11. REQUIREMENTS FOR CONSTRUCTION ON CORPS OF ENGINEERS PROPERTY
  - 11.1 Not Used
12. CATALOG DATA FOR OWNERS
  - 12.1 Provide in triplicate complete, bound sets of a compilation of catalog data of each manufactured item of mechanical and electrical equipment used in the work, and present this compilation to the A/E for transmittal to the Owner before payment of more than ninety percent (90%) is made. Include descriptive data and printed installation, operating, and maintenance instructions (including a parts list for each item of equipment). Provide a complete double index as follows:
    - A. Listing the products alphabetically by name
    - B. Listing alphabetically the names of manufacturers whose products have been incorporated in the work, together with their addresses and the names and addresses of the local sales representative.
13. INSTALLATION, TESTING, AND GUARANTEE
  - 13.1 Install all motor driven equipment exactly in accordance with the manufacturer's recommendations. Do not operate the units except to check the direction of rotation, etc., unless a representative of the manufacturer-who shall perform all required field-testing-is present. The completely installed system shall be guaranteed against any and all defects of manufacture, materials, workmanship, or installation for a period of one (1) year from the date of acceptance.
14. OPERATIONS AND MAINTENANCE, INSTRUCTION TO OWNER
  - 14.1 Where the specifications for specific equipment require that a factory service representative provide operation and maintenance instruction to the Owner for that equipment, this service shall be performed with the Owner's representative present as to allow proper training and instruction of the specific equipment. This instruction and training shall be scheduled with the owner's representative and shall be provided as an additional training and instruction to that which is specifically listed in section 01730 "Instructions to Owner for operation & Maintenance". This instruction and training shall also be in addition to the manufacturer's instructions to the Contractor for installation and start-up. The individual performing the instructions to the Owner shall be trained and/or certified by the manufacturer as its authorized operation, maintenance, and service specialist. If the said specialist is not a regular full-time employee of the Manufacturer, the specialist's qualifications shall be submitted to the Owner and A/E for review and approval prior to scheduling the site visit for instructions to the Owner.
15. DRAWINGS OF RECORD
  - 15.1 The Contractor shall provide and keep up-to-date a complete record set of blueline prints, which shall be corrected daily to show every change, and the

approved shop drawings. Keep this set of prints at the job site, and use only as a record set. This shall not be construed as authorization for the Contractor to make changes in the approved layout without definite instructions in each case. Turn the set over to the A/E upon completion of the project. Prior to closeout of the project the A/E shall provide to the contractor a clean set of plans in which the contractor shall show all revisions with red pencil as to allow the A/E to transfer this revised information onto a set of Record Drawings.

## 16. PRESERVATION OF EXISTING VEGETATION

- 16.1 Take reasonable care during construction to avoid damage to existing vegetation. Where the area to be excavated is occupied by trees, brush, or other uncultivated vegetative growth, clear such growth from the area, and dispose of it in a satisfactory manner. Leave undisturbed any trees, cultivated shrubs, flowers, etc., situated within public rights-of-way and/or easements through private property but not located directly within excavation limits. Transplant small ornamental trees, cultivated shrubs, flowers, etc., located directly within excavation limits so they may be replaced during property restoration operations. Do not remove or disturb any tree larger than six inches (6") in diameter without the permission of the A/E. Take special precautions (including the provision of barricades and the temporary tying back of shrubbery and tree branches) for the protection and preservation of such objects throughout all stages of construction; the Contractor will be held liable for any damage that may result to said objects from excavation or construction operations. Trim any limbs or branches of trees broken during construction operations with a clean cut, and paint with an approved tree pruning compound. Treat with a tree dressing tree trunks receiving damage from equipment

## 17. WASTEWATER BYPASSING

- 17.1 No wastewater bypassing or backwash lagoon discharging shall be allowed during construction and/or treatment plant startup unless a schedule has been approved by the Division of Water Quality Control and the U. S. Environmental Protection Agency pursuant to the terms of any applicable NPDES permit.

## 18. UTILITIES

- 18.1 The Contractor shall contact the owner of all underground utilities before beginning construction in the area. Carefully protect from damage all utilities in the vicinity of the work at all times. The existing utilities are shown in an approximate location on the plans therefore, the contractor shall exactly locate all utilities prior to any excavation in the general vicinity of the existing utility. The contractor shall verify the location of all existing utilities in the area (whether shown on the plans or not) prior to any excavation in the vicinity. Excavation in the area of existing utilities shall be coordinated with the utility company as to allow proper field supervision. If it is necessary to repair, remove, and/or replace any such utility in order to complete the work property, do so in compliance with the rules and regulations of the particular utility involved. Any damage to existing utilities and any necessary repair work shall be considered incidental to the

construction of the project, and no additional payment will be allowed to the contractor.

19. TRAFFIC CONTROL

- 19.1 The contractor shall provide adequate traffic control devices, flagmen, barricades and all necessary items as to allow the public vehicular traffic to progress without timely delays. Lane and road closures requests shall be submitted for review within the Traffic Control Plan.
- 19.2 The contractor shall maintain roadways until permanent repair is performed (if damaged during construction). All roadways will be kept clean of mud, sediment, loose gravel, oils, and debris throughout the project.
- 19.3 The contractor shall be responsible for any and all vehicular damage claims as a result of non-maintained construction damage of roadways that contributes to damage of vehicles.

20. EROSION CONTROL

- 20.1 An erosion control plan shall be submitted to the A/E for review and approval prior to commencement of construction for each contract. The erosion control plan shall include preventative and construction measures in accordance with the Kentucky Division of Water NPDES regulations and all other local state and federal erosion and sediment control regulations. The contractor shall adhere to all guidelines during construction of the water treatment plant, backwash lagoon construction, and site grading. Adhere to the KYDOT encroachment permit for construction along state highways. The contractor shall finish grade, seed and straw disturbed areas as soon as possible to prevent sediment runoff from occurring. Silt fencing, staked straw bales, sediment traps, berms, erosion control matting, riprap and additional measures shall be utilized during construction to prevent sediment runoff and erosion.

21. SEQUENCE OF WORK AND USE OF PREMISES

- 21.1 The Contractor shall schedule the sequence of his work to provide the least practical amount of interruption to the public and traffic patterns. The contractors of each contract shall be required to coordinate their work with the other contractors at the beginning and termination points of each contract. The contractors shall also be required to provide full cooperation with the other contractors throughout the project. The A/E will evaluate and direct the contractors of any questionable coordination of work items between the beginning and ending of contract points as to determine which contractor is responsible for certain tie on work. It is generally understood that the contractor who is the latest on reaching the connection point with his work is responsible for the connection work.
- 21.2 Any disruption of service public services shall be reinstated as soon as possible. The contractor shall provide repair services or coordinate with the local utility and stay on the project until service has been fully reinstated.

## 22. INSURANCE

The Contractor shall procure, maintain, and furnish an Owner's and Engineer's protective policy as hereinafter specified:

Owner's and Engineer's General Public Liability and Property Damage Insurance including vehicle coverage issued to the Owner and Engineer and protecting the Owner and Engineer from all claims for personal injury, including death, and all claims for destruction of or damage to property, arising out of or in connection with any operations under the Contract Documents, whether such operations be by the Contractor by any Subcontractor employed by the Contractor or anyone directly or indirectly employed by the Contractor or by a Subcontractor employed by the Contractor. Insurance shall be written with a limit of liability of not less than \$1,000,000 for all damages arising out of bodily injury, including death, at any time resulting therefrom, sustained by any one person in any one accident; and a limit of liability of not less than \$1,000,000 aggregate for any such damages sustained by two or more persons in any one accident Insurance shall be written with a limit of liability of not less than \$500,000 for all property damage sustained by any one person in any one accident; and a limit of liability of not less than \$500,000 aggregate for any such damage sustained by two or more persons in any one accident

This requirement for an Owner's and Engineer's protective policy shall be in addition to any and all other insurance requirements as set forth in the Contract Documents.

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. Coordination of work of the Contract.

**1.2 RELATED REQUIREMENTS**

- A. Section 01031 -Special Project Procedures.
- B. Section 01045 - Cutting and Patching.
- C. Section 01200 - Project Meetings.
- D. Section 01600 - Material and Equipment: Product options and substitutions.
- E. Section 01700 - Contract Closeout: Closeout submittals.

**1.3 DESCRIPTION**

- A. The Contractor shall be responsible for coordinating all portions of the work related to the project, and the failure to fully and completely coordinate all phases of the work shall not relieve the Contractor of any contract requirements.
- B. Coordinate scheduling, submittals, and work of the various Sections of Specifications to assure efficient and orderly sequence of installation of construction elements, with provisions for accommodating items to be installed later.
- C. Coordinate sequence of work to accommodate Owner occupancy and continuous operation of the existing facilities.

**1.4 MEETINGS**

- A. In addition to progress meetings specified in Section 1200, hold coordination meetings and pre-installation conferences with personnel and subcontractors to assure coordination of work.



## 1.5 COORDINATION OF SUBMITTALS

- A. Schedule and coordinate submittals specified in Section 1300.
- B. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment
- C. Coordinate requests for substitutions to assure compatibility of space, of operating elements, and effect on work of other sections.

## 1.6 COORDINATION OF SPACE

- A. Coordinate use of Project space and sequence of installation of mechanical, plumbing, and electrical work that is indicated diagrammatically on Drawings, if applicable. Follow routings shown for pipes, ducts, and conduits as closely as practicable, with due allowance for available physical space; make runs parallel with lines of building. Utilize space efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- B. In finished areas (except as otherwise shown) conceal pipes, ducts, and wiring in the construction. Coordinate locations of fixtures and outlets with finish elements.

## 1.7 COORDINATION OF CONTRACT CLOSEOUT

- A. Coordinate completion and cleanup of work of separate sections in preparation for Substantial Completion.
- B. After Owner occupancy of premises, coordinate access to site by various sections for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.
- C. Assemble and coordinate closeout submittals specified in Section 01700.

## PART 2. PRODUCTS

### 2.1 NOT USED

## PART 3. EXECUTION

### 3.1 NOT USED

END OF SECTION

PART 1. GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Requirements and limitations for cutting and patching of Work.

1.2 RELATED REQUIREMENTS

- A. Section 01031 - Special Project Procedures: Work by Owner or by separate contractors.
- B. Section 01600 - Materials and Equipment: Substitutions.
- C. Individual Specifications Sections:
  - 1. Cutting and patching incidental to work of the Section.
  - 2. Advance notification to other Sections of openings required in work of those Sections.
  - 3. Limitations on cutting structural members.

1.3 DESCRIPTION

- A. "Cutting and patching" is hereby defined to include, but is not necessarily limited to, the cutting and patching of nominally completed and/or previously existing work, in order to accommodate the coordinator of work, or the installation of other work, or to uncover other work for access or inspection, or to obtain samples for testing, or for similar purposes; and is defined to exclude integral cutting and patching during the manufacturing, fabricating, erecting and installing process for individual units of work. Drilling the work to install fasteners and similar operations is excluded from the definition of cutting and patching. "Cutting and Patching" shall also include work that is determined to be unsatisfactory visually or structurally as determined by the A/E and owner.
- B. Refer to other Sections of these specifications for specific cutting and patching requirements and limitations applicable to individual units of work.
- C. Do not cut and patch structural work in a manner resulting in a reduction of load carrying capacity or load/deflection ratio.
- D. Do not cut and patch operational elements and safety-related components in a manner resulting in a reduction of capacities to perform in the manner intended or resulting in decreased operational life, increased maintenance, or decreased safety.

- E. Do not cut and patch work which is exposed on the exterior or exposed in occupied spaces of the building, in a manner resulting in a reduction of visual qualities or resulting in substantial evidence of the cut and patch work, as judged solely by the A/E. Remove and replace work judged by the A/E to be cut and patched or to be of unsatisfactory quality in a visually or structural manner.

#### 1.4 SUBMITTALS

- A. Submit written request in advance of cutting or alteration that affects:
  - 1. Structural integrity of any element of Project.
  - 2. Integrity of weather-exposed or moisture-resistant elements.
  - 3. Efficiency, maintenance, or safety of any operational elements.
  - 4. Visual qualities of sight-exposed elements.
  - 5. Work of Owner or separate contractor.
- B. Include in written request:
  - 1. Identification of Project.
  - 2. Location and description of affected work.
  - 3. Necessity for cutting or alteration.
  - 4. Affect on other work and on structural integrity of the project.
  - 5. In the description of proposed work, designate:
    - a. Scope of cutting and patching.
    - b. Contractor and trades to execute work.
    - c. Products to be used.
    - d. Extent of refinishing.
  - 6. Alternatives to cutting and patching.
  - 7. Designation of party responsible for cost of cutting and patching.
  - 8. Effect on work of Owner or separate contractor.
  - 9. Written permission of affected separate contractor.
  - 10. Date and time work will be executed to allow observation.
  - 11. Submit cost estimate prior to cutting and patching done on instruction of the A/E, except such work as included in paragraph 1 3.E above.

#### 1.5 PAYMENT FOR COSTS

- A. The Contractor shall be responsible for costs caused by ill-timed or defective work, or work not complying with the contract documents, including costs for additional services of the A/E.

### PART 2. PRODUCTS

#### 2.1 MATERIALS

- A. For replacement of work removed: Comply with the specifications for type of work to be done.
- B. For existing work being placed or repaired: Match existing.
- C. For any change in materials: Submit request for substitution under provisions of Section 01600.

### PART 3. EXECUTION

#### 3.1 GENERAL

- A. Execute cutting, fitting, and patching including excavation and fill, to complete work, and to:
  - 1. Fit the several parts together, to integrate with other work.
  - 2. Uncover work to install ill-timed work.
  - 3. Remove and replace defective work.
  - 4. Remove samples of installed work as specified for testing.
  - 5. Remove and replace work not conforming to the requirements of the contract documents.
  - 6. Provide openings in elements of work for penetrations of mechanical and electrical work.
  - 7. Install specified work in existing construction
- B. In addition to contract requirements, upon written instructions of the A/E:
  - 1. Uncover work to provide for the A/E's observation of covered work.
  - 2. Remove samples of installed materials for testing.
  - 3. Remove work to provide for alteration of existing work.
- C. Do not endanger any work by cutting or altering work or any part of it.
- D. Do not cut or alter work of another Contractor without written consent of the A/E:

#### 3.2 INSPECTION

- A. Inspect existing conditions, including elements subject to damage or movement during:
  - 1. Cutting and patching.
  - 2. Excavating and backfilling.
- B. After uncovering, inspect conditions affecting performance of work and installation of new materials.
- C. Beginning of cutting or patching means acceptance of existing conditions.

#### 3.3 PREPARATION

- A. Provide shoring, bracing, and supports to assure structural integrity of surroundings, devices, and methods to protect other portions of Project from damage.
- B. Provide protection from elements for areas that may be exposed by uncovering work; maintain excavations free of water.

### 3.1 PERFORMANCE

- A. Execute work by methods to avoid damage to other work, and which will provide proper surfaces to receive patching and finishing and prevent settlement.
- B. Employ original installer to perform cutting and patching for weather-exposed and moisture-resistant elements and sight-exposed surfaces.
- C. Cut rigid materials using masonry saw or core drill. Pneumatic tools shall not be allowed without prior approval.
- D. Restore work with new products in accordance with requirements of Contract Documents.
- E. Fit work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- F. At penetrations of fire-rated wall, ceiling, or floor construction, completely seal voids with fire-rated material, full thickness of the construction element.
- G. Execute fitting and adjustment of products to provide finished installation to comply with specified tolerances and finishes.
- H. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.

END OF SECTION

## SECTION 01060

### REGULATORY REQUIREMENTS

#### PART 1 GENERAL

##### 1.01 LABOR REGULATIONS ON PUBLIC WORKS PROJECTS

- A. All Public Works projects submitted for bids and construction by a Public Authority are subject to the provisions of the state's Statutes. CONTRACTORS submitting bids for the specified project must consider the fact that in the event of an award it shall be his responsibility to comply with all aspects of the statutory requirements contained therein while engaged upon the project covered by these specifications.

##### 1.02 ACCESS TO WORK

- A. The representatives of the OWNER, the ENGINEER, the U.S. Federal Department of Housing and Urban Development, Department of Agriculture, Farmers Home Administration, the Division of Water, OSHA and related agencies shall have access to the work wherever it is in preparation or progress, and the CONTRACTOR shall provide proper facilities for such access and inspection.

##### 1.03 LOCAL GOVERNMENT REQUIREMENTS

- A. The CONTRACTOR and all subcontractors and suppliers shall fully comply with all local government requirements.

#### PART 2 PRODUCTS

Not Used.

#### PART 3 EXECUTION

Not Used.

END OF SECTION

## PART 1. GENERAL

## 1.1 REQUIREMENTS INCLUDED

- A. Applicability of Reference Standards.
- B. Provision of Reference Standards at site.
- C. Acronyms used in Contract Documents for Reference Standards. Source of Reference Standards.

## 1.2 QUALITY ASSURANCE

- D. For products or workmanship specified by association, trade, or Federal Standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- E. The date of the standard is that in effect as of the Bid date, except when a specific date is specified.
- F. When required by individual Specifications section, obtain copy of standard. Maintain copy at jobsite during sub-mittals, planning, and progress of the specific work, until Substantial Completion.

## 1.3 SCHEDULE OF REFERNECES

AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol Street, N.W. Washington, DC 20001
ACI	American Concrete Institute P.O. Box 19150 Reford Station Detroit, MI 48219

AGC	Associated General Contractors of America 1957 E. Street, N.W. Washington, DC 20006
AI	Asphalt Institute Asphalt Institute Building College Park, MD 20740
AISC	American Institute of Steel Construction 400 North Michigan Avenue Eighth Floor Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, DC 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
AWPA	American Wood-Preservers Association 7735 Old Georgetown Road Bethesda, MD 20014
AWS	American Welding Society 550 LeJeune Road Miami, FL 33135



CLFMI	Chain Link Fence Manufacturers Institute 1101 Connecticut Avenue, N.W. Washington, DC 20036
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195
EJCDC	Engineers Joint Contract Documents Committee American Consulting Engineers Council 1050 15th Street, N.W. Washington, DC 20005
EJMA	Expansion Joint Manufacturers Association 707 Westchester Avenue White Plains, NY 10604
FM	Factory Mutual System 1151 Boston-Providence Turnpike Norwood, MA 02062
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
GA	Gypsum Association 1603 Orrington Avenue Evanston, IL 60201
IEEEC	Institute of Electrical and Electronics Engineers 345 East 47th Street New York, NY 10017 IMI International Masonry Institute 815 15th Street, N.W. Washington, DC 20005
MIL	Military Specification Naval Publications and Forms Center 5801 Tabor Avenue Philadelphia, PA 19120
MUSFA	Metal Lath/Steel Framing Association

	221 North LaSalle Street Chicago, IL 60601
NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NEBB	National Environmental Balancing Bureau 8224 Old Courthouse Road Vienna, VA 22180
NEMA	National Electrical Manufacturers Association 2101 L Street, N.W. Washington, DC 20037
NFPA	National Forest Products Association 1619 Massachusetts Avenue, N.W. Washington, DC 20036
NSWMA	National Solid Waste Management Association 1120 Connecticut Avenue, N.W. Washington, DC 20036
NTMA	National Terrazzo and Mosaic Association 3166 Des Plaines Avenue Des Plaines, IL 60018
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
PI	Prestressed Concrete Institute 201 North Wacker Drive Chicago, IL 60606
PS	Product Standard U. S. Department of Commerce Washington, DC 20203
SDI	Steel Deck Institute P.O. Box 3812 St. Louis, MO 63122
SIGMA	Sealed Insulating Glass Manufacturers Association 111 East Wacker Drive Chicago, IL 60601

SJI	Steel Joist Institute 1703 Parham Road Suite 204 Richmond, VA 23229
SMACNA	Sheet Metal and Air Conditioning Contractors National Association 8824 Old Court House Road Vienna, VA 22180
SSPC	Steel Structures Painting Council 4400 Fifth Avenue Pittsburgh, PA 15213
TAS	Technical Aid Series Construction Specifications Institute 601 North Madison Street Alexandria, VA 22314
TCA	Tile Council of America, Inc. P.O. Box 326 Princeton, NJ 08540
UL	Underwriters Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

## PART 2. PRODUCTS

2.1 Not Used.

## PART 3. EXECUTION

3.1 Not Used.

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. Contractor participation in preconstruction conferences.
- B. Contractor administration of progress meetings and pre-installation conferences.

**1.2 RELATED REQUIREMENTS**

- A. Section 00140 - Information for Bidders: Pre-Bid Inspection.
- B. Section 01040 - Coordination.
- C. Section 01300 - Submittals: Progress Schedules.
- D. Section 01300 - Submittals: Shop drawings, product data, and samples.
- E. Section 01400 - Quality Control.
- F. Section 01700 - Contract Closeout: Project record documents.
- G. Section 01730 - Instructions to Owner for Operation Maintenance: Operation and maintenance data.

**1.3 PRECONSTRUCTION CONFERENCES.**

- A. A/E shall schedule conference within fifteen (15) days after approval and execution of the contract documents, at a time suitable to the Owner and Contractor.
- B. Attendance: Owner's representative, A/E, Contractor, and major Sub-Contractors.

C Suggested Agenda:

1. Submittal of list of subcontractors, list of products, schedule of values, and progress schedule.
2. Designation of responsible personnel.
3. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal requests, change orders, and contract closeout procedures.
4. Scheduling.
5. Use of premises by Owner and Contractor.
6. Owner's requirements.
7. Security and housekeeping procedures.
8. Procedures for testing.
9. Procedures for maintaining record documents.
10. Requirements for startup of equipment.
11. Inspection and acceptance of equipment put into service during construction period.

1.4 PROGRESS MEETINGS - Contractor's Responsibilities

- A. Schedule and administer Project meetings throughout progress of the work at maximum monthly intervals, called meetings, and pre-installation conferences, as applicable.
- B. Make physical arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within two days to A/E, participants, and those affected by decisions made at meetings.
- C. Attendance: Job superintendent, major subcontractors and suppliers; Owner's representative and A/E, as appropriate to agenda topics for each meeting.
- D. Suggested Agenda:
  1. Review of Work progress.
  2. Status of progress schedule and adjustments thereto.

3. Delivery schedules.
4. Submittals.
5. Maintenance of quality standards.
6. Pending changes and substitutions, coordination of trades (subs) report.
7. Other items affecting progress of work.

#### 1.5 PRE-INSTALLATION CONFERENCES

- A. When required in individual specification Section, convene a pre-installation conference prior to commencing work of the Section.
- B. Require attendance of entities directly affecting, or affected by, work of the Section.
- C. Review conditions of installation, preparation and installation procedures, and coordination with related work.

#### PART 2. PRODUCTS

##### 2.1 NOT USED

#### PART 3. EXECUTION

##### 3.1 NOT USED

END OF SECTION

## SECTION 01210 ALLOWANCES

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements governing allowances.
  - 1. Certain items are specified in the Contract Documents by allowances. Allowances have been established in lieu of additional requirements and to defer selection of actual materials and equipment to a later date when additional information is available for evaluation. If necessary, additional requirements will be issued by Change Order.
- B. Types of allowances include the following:
  - 1. Lump-sum allowances.
  - 2. Unit-cost allowances.
  - 3. Quantity allowances.
  - 4. Contingency allowances.
  - 5. Testing and inspecting allowances.

#### **1.2 RELATED DOCUMENTS:**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification-Sections, apply to this Section.
- B. Related work specified elsewhere includes:
  - 1. Divisions 2 through 16

#### **1.3 SELECTION AND PURCHASE**

- A. At the earliest practical date after award of the Contract, advise ENGINEER of the date when final selection and purchase of each product or system described by an allowance must be completed to avoid delaying the Work.
- B. At ENGINEER'S request, obtain proposals for each allowance for use in making final selections. Include recommendations that are relevant to performing the Work.
- C. Purchase products and systems selected by ENGINEER from the designated supplier.

#### **1.4 SUBMITTALS**

- A. Submit proposals for purchase of products or systems included in allowances, in the form specified by ENGINEER.
- B. Submit invoices or delivery slips to show actual quantities of materials delivered to the site for use in fulfillment of each allowance.
- C. Coordinate and process submittals for allowance items in same manner as for other portions of the Work.

1.5 COORDINATION

- A. Coordinate allowance items with other portions of the Work. Furnish templates as required to coordinate installation.

1.6 LUMP SUM, UNIT-COST, AND QUANTITY ALLOWANCES

- A. Allowance shall include cost to CONTRACTOR of specific products and materials ordered by OWNER under allowance and shall include taxes, freight, and delivery to Project site.
- B. CONTRACTOR'S costs for receiving and handling at Project site, labor, installation, overhead and profit, and similar costs related to products and materials ordered by OWNER under allowance shall be included as part of the Contract Sum and not part of the allowance.
- C. At Project closeout, credit unused amounts remaining in these allowances to OWNER by Change Order.

1.7 CONTINGENCY ALLOWANCES

- A. Use the contingency allowance only as directed by ENGINEER for OWNER'S purposes and only by Change Orders that indicate amounts to be charged to the allowance.
- B. CONTRACTOR'S overhead, profit, and related costs for products and equipment ordered by OWNER under the contingency allowance are included in the allowance and are not part of the Contract Sum. These costs include delivery, installation, taxes, insurance, equipment rental, and similar costs.
- C. Change Orders authorizing use of funds from the contingency allowance will include CONTRACTOR'S related costs; and overhead and profit margins in accordance with General Conditions of this Project.
- D. At Project closeout, credit unused amounts remaining in the contingency allowance to OWNER by Change Order.

1.8 TESTING AND INSPECTING ALLOWANCES

- A. Testing and inspecting allowances include the cost of engaging testing agencies, actual tests and inspections, and reporting results.
- B. The allowance does not include incidental labor required to assist the testing agency or costs for retesting if previous tests and inspections result in failure. The cost for incidental labor to assist the testing agency shall be included in the Contract Sum.
- C. Costs of services not required by the Contract Documents are not included in the allowance.
- D. At Project closeout, credit unused amounts remaining in the testing and inspecting allowance to OWNER by Change Order.

1.9 UNUSED MATERIALS

- A. Return unused materials purchased under an allowance to manufacturer or supplier for credit to OWNER, after installation has been completed and accepted.
  - 1. If requested by ENGINEER, prepare unused material for storage by OWNER when it is not economically practical to return the material for credit. If directed by ENGINEER, deliver unused



material to OWNER'S storage space. Of Otherwise, disposal unused material is CONTRACTOR'S responsibility.

**PART 2 PRODUCTS (NOT USED)**

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Examine products covered by an allowance promptly on delivery for damage or defects. Return damaged or defective products to manufacturer for replacement.

3.2 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related work.

3.3 SCHEDULE OF ALLOWANCES

- A. The following allowances shall be included in Contract Sum in accordance with the allowance type described above. Should the below allowances not be shown on the project proposal, the Contractor shall include them in the total bid cost.

Allowance No.	Description	Allowance Type	Section	Amount
1.	Materials Testing	Testing and Inspection	01410	\$65,000
2.	Unsuitable Material Building and Bedding Construction	Cubic Yard Replaced by Stone	02221, 02594, 02600	\$125,000
3.	Above and beyond Base Bid, Cast in Place concrete reinforced structural concrete, complete in place.	Cubic Yard	Division 03	\$30,000
4.	Above and beyond base bid, asphalt paving, complete in place.	Ton	KYTC Section 400	\$10,000
5.	Above and beyond base bid, 24" ADS N-12 storm piping, complete in place.	LF	02610	\$10,000
6.	Above and beyond base bid 18" ductile iron pipe, complete in place.	LF	02610	\$2,500

END OF SECTION

## PART 1. GENERAL

### 1.1 REQUIREMENTS INCLUDED

- A. Procedures.
- B. Construction Progress Schedules.
- C. Schedule of Values.
- D. Shop Drawings.
- E. Product Data.
- F. Samples.
- G. Manufacturers' Instructions.
- H. Manufacturers' Certificates.

### 1.2 RELATED REQUIREMENTS

- A. Section 01031 - Special Project Procedures: Work sequence.
- B. Section 01400 - Quality Control: Testing laboratory reports and manufacturer's field service reports.
- C. Section 01600 - Material and Equipment: Contractor's list of Products.
- D. Section 01700 - Contract Closeout: Closeout submittals.

### 1.3 QUALITY ASSURANCE

- A. Description of work included
  - 1. Wherever possible throughout the Contract Documents, the minimum acceptable quality of workmanship and materials has been defined by a manufacturer's name and catalogue number, reference to recognized

industry and government standards, or description of required attributes and performance.

2. To ensure that the specified products are furnished and installed in accordance with the design intent, procedures have been established for advance submittal of design data and for their review by the A/E.
3. Make all submittals required by the contract documents and revise and resubmit as necessary to establish compliance with the specified requirements.

B. Coordination of Submittals

1. Prior to each submittal, carefully review and coordinate all aspects of each item being submitted, and verify that each item and the submittal for it conforms in all respects with the requirements of the bidding instruments.
2. Shop drawings and submittals shall bear the stamp of approval of the Contractor as evidence that this coordination has been performed. Submittals without this stamp of approval shall not be considered but shall be returned for proper resubmission. The submittal shall not include a date or time frame wherein shop drawings and/or other submittals must be returned by the A/E to the Contractor.

C. Certificates of Compliance

1. Certify that all materials used in the work comply with all specified provisions thereof. Certification shall not be construed as relieving the Contractor from the responsibility to furnish satisfactory materials if, after tests are performed on selected samples, the material is found not to meet specified requirements.
2. Show on each certification the name and location of the work, the name and address of the Contractor, the quantity and date or dates of shipment or delivery to which the certificate applies, and the name of the manufacturing or fabricating company. Certification shall be in the form of a letter or company-standard forms containing all required data. Certificates shall be signed by an officer of the manufacturing or fabricating company.
3. In addition to the above information, all laboratory test reports submitted with certificates of compliance shall show the date or dates of testing, the specified requirements for which testing was performed, and the results of the test or tests.

4. PROCEDURES

- A. Deliver or mail submittals to:
  
- B. Transmit each item under A/E-accepted form. Identify Project, Contractor, subcontractor, and major supplier; identify pertinent Drawing sheet and detail number, and Specification Section number, as appropriate. Identify deviations from Contract Documents. Provide space for Contract A/E review stamps.
- C. Within seven (7) days of notification of award of contract, submit the following:
  - 1. Complete list of proposed subcontractors.
  - 2. Complete list of materials suppliers, including brand names (to be furnished as outlined in Instructions to Bidders).
  - 3. Complete list of major equipment suppliers, including model numbers for identification.
  - 4. Before beginning any on-site construction, submit insurance certificates.
- D. Within twenty (20) days after execution of contract between Owner and General Contractors submit:
  - 1. Complete construction progress schedule as described elsewhere in this section.
  - 2. Two (2) copies of the schedule of shop drawing submittals as described elsewhere in this section.
  - 3. Schedule of values as described elsewhere in this Section.
  - 4. The job sign, if applicable.
- E. Within thirty (30) days after execution of contract between Owner and General Contractor, submit:
  - 1. All required samples for color selection under one (1) cover letter or transmittal letter.
  - 2. Comparative literature and samples required for architectural product substitutions.
  - 3. Any mock-up or model of the work to be built that may be required by the Contract Documents.
- F. Comply with progress schedule for submittals related to work progress. Coordinate submittal of related items.

- G. After A/E review of submittal, revise and resubmit as required, identifying changes made since previous submittal.
- H. Distribute copies of reviewed submittals to concerned persons. Instruct recipients to promptly report any inability to comply with provisions.

#### 1.5 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit horizontal bar chart with separate bar for each major trade or operation, identifying first workday of each week.
- B. Show complete sequence of construction by activity, identifying work of separate stages and other logically grouped activities. Show projected percentage of completion for each item of work as of time of each Application for Progress Payment.
- C. Show submittal dates required for shop drawings, product data, and samples, and product delivery dates, including those furnished by Owner and those under Allowances.

#### 1.6 SCHEDULE OF VALUES

- A. Submit typed schedule on NSPE Schedule Form or AIA Form G703, or a media-driven printout will be considered on request, with prior approval by A/E.
- B. Format Table of Contents of this Project Manual. Identify each line item with number and title of the major Specification Sections.
- C. Include in each line item a directly proportional amount of Contractor's overhead and profit.
- D. Revise schedule to list change orders, for each application for payment.

#### 1.7 PRODUCT DATA

- A. Mark each copy to identify applicable products, models, options, and other data; supplement manufacturers' standard data to provide information unique to the work.
- B. Submit the number of copies that Contractor requires, plus three (3) copies that will be retained by A/E.

#### 1.8 MANUFACTURER'S INSTRUCTIONS

- A. When required in individual Specification Section, submit manufacturer's printed instructions for delivery, storage, assembly, installation start-up, adjusting, and finishing, in quantities specified for product data.

## 1.9 SAMPLES

- A. Submit full range of manufacturers' standard colors, textures, and patterns for A/E's selection by the Owner.
- B. Submit samples to illustrate functional characteristics of the product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing work.
- C. Include identification on each sample, giving full information.
- D. Submit the number specified in respective Specification Section; one (1) will be retained by A/E. Reviewed samples which may be used in the work are indicated in the Specification Section, if applicable.

## 1.10 FIELD SAMPLES

- A. Provide field samples of finishes at Project as required by individual Specification Section. Install sample complete and finished. Acceptable samples in place may be retained in completed work.

# PART 2. PRODUCTS

## 2.1 SUBMITTAL SCHEDULE

- A. General: Compile a complete and comprehensive schedule of all submittals anticipated to be made during the progress of the work. Include a list of each type of item from which the Contractors drawings, shop drawings, certificates of compliance, material samples, guarantees, or other types of submittals are required. Upon approval by the A/E, this schedule will become part of the contract, and the Contractor will be required to adhere to the schedule except when specifically otherwise permitted.
- B. Coordination: Coordinate the schedule with all necessary subcontractors' and materials suppliers to ensure their understanding of the importance of adhering to the approved schedule and their ability to so adhere. Coordinate as required to ensure the grouping of submittals as described in Paragraph 3.2 of this Section.
- C. Revisions: Revise and update the schedule on a monthly basis as necessary to reflect conditions and sequences. Promptly submit the revised schedules to the A/E for review and comment. The revised schedule shall be presented at the construction progress meeting as to allow review by the owner's representative, A/E, contractor, and major subcontractors.

## 2.2 SHOP DRAWINGS AND COORDINATION OF DRAWINGS

### A. Shop Drawings

1. Scale and Measurements: Make all shop drawings accurately to a scale large enough to show all pertinent aspects of the item and its method of connection to the work.
2. Type of Prints Required: Submit the number of copies that the Contractor requires, plus three (3) copies that will be retained by A/E. Blueprints will be acceptable, provided they are legible throughout.

## 2.3 MANUFACTURERS' LITERATURE

- A. General: Where the contents of submitted literature from the manufacturer includes data not pertinent to the submittal, clearly indicate which portion of the contents is being submitted for review.
- B. Number of Copies Required: Submit the number of copies that are required to be returned to the Contractor, plus three (3) copies to be retained by the A/E.

## 2.4 SAMPLES

- A. Accuracy of Samples: Samples shall be of the precise article proposed to be furnished.
- B. Number of Samples Required: Unless otherwise specified, submit all samples in the quantity that is required to be returned plus one (1) copy to be retained by the A/E.
- C. Reuse of Samples: In situations specifically so approved by the A/E, the A/E's retained sample may be used in the construction as one of the installed items.

## 2.5 COLORS AND PATTERNS

- A. Unless the precise color and pattern are specifically described in the Contract Documents, and whenever a choice of color or pattern is available in a specified product, submit accurate color and pattern charts to the A/E for review and selection by the Owner.

## 3. EXECUTION

### 3.1 IDENTIFICATION OF SUBMITTALS

- A. General: Consecutively number all submittals. Each submittal shall be accompanied with a letter of transmittal that itemizes all data transmitted that contains all pertinent information required for identification and checking of submittals.

- B. Internal Identification: On at least the first page of each copy of each submittal, and elsewhere as required for positive identification, clearly indicate the submittal number in which the item was included.
- C. Re-submittals: When material is resubmitted for any reason, transmit under a new letter of transmittal and with original submittal number.
- D. Submittal Log: Maintain an accurate submittal log for the duration of the contract that shows the ament status of all submittals at all times. Make the submittal log available for the A/E's review upon request.

### 3.2 COORDINATION OF SUBMITTALS

- A. General: Prior to submittal for approval, use all means necessary to coordinate fully all material, including but not necessarily limited to the following:
  - 1. Determine and verify ail interface conditions, catalogue numbers and similar data.
  - 2. Coordinate with other trades as required.
  - 3. Submittals shall contain rating data on equipment and accessories. Features shall be described as specified herein, and capacities shall be stated in the same terms as those specified.
  - 4. Note deviations from the Contract Documents on the submittal so that, if acceptable, suitable action may be taken for proper adjustment if no deviations are noted, it is assumed that the material folly meets the specified requirements; therefore, the Contractor shall not be relieved of the responsibility for executing the work in accordance with the contract.
- B. Grouping of Submittals: Unless otherwise specified, make all submittals in groups containing all associated items to ensure that information is available for checking each item when it is received. Partial submittals may be rejected as not complying with the provisions of the contract documents, and the Contractor shall be strictly liable for all delays so occasioned.

### 3.3 TIMING OF SUBMITTALS

- A. General:
  - 1. Make all submittals far enough in advance of scheduled dates for installation to provide all time required for reviews, for securing necessary approvals, for possible revisions and re-submittals, and for placing orders and securing delivery.



2. Submit shop drawings in accordance with the approved schedule of shop drawing submittals.
- B. A/E's Review Time: In scheduling, allow at least twenty-one (21) working days for review by the A/E following his receipt of the submittal. Allow twenty (24) working days for review of laboratory furniture and major equipment submittals.
- C. Delays: Delays caused by tardiness in receipt of submittals will not be an acceptable basis for extension of the contract completion date.

#### 3.4 A/E'S REVIEW

- A. Revisions:
1. Make all revisions required by the A/E, including those relating to artistic effort. If the Contractor considers any required revision to be a change, he shall so notify the A/E as provided for under "Changes" in the General Conditions. Show each drawing revision by number, date, and subject in a revision block on the drawing. Make only those revisions directed or approved by the A/E.
  2. After making the corrections required by the AE, file six (6) corrected copies with the A/E, and furnish additional copies as needed.
  3. The AE's approval of submittals does not relieve the Contractor from responsibility for their correctness in all aspects.
- B. Revisions After Approval: When a submittal has been reviewed by the AE, re-submittal for substitutions of materials or equipment will not be considered unless accompanied by an acceptable explanation as to why the substitution is necessary.

END OF SECTION

1. This Section specifies the requirements of submittals for those items of equipment specifically mentioned in their respective sections of the specifications as needing approval in accordance with the provisions of this Section. This approval shall be in writing. Equipment submittals shall be made in accordance with applicable portions of the provisions of Section 01300, Submittals. The Contractor shall submit the following:
  - 1.1 Complete descriptive and dimensional data;
  - 1.2 Operation and maintenance manuals with parts list;
  - 1.3 Installation instructions;
  - 1.4 Characteristic curves for the following equipment:
    - 1.4.1 Air compressors or blowers (showing brake horsepower and static pressure plotted against capacity); and
    - 1.4.2 Pumping equipment (showing brake horsepower, total head, efficiency, and NPSHR plotted against capacity).
2. Along with the above shop drawing package, the supplier shall submit the following, through the Contractor:
  - 2.1 The manufacturer shall certify in writing that he has thoroughly familiarized himself with the proposed usage of and installation arrangements for the product and that it is the manufacturer's opinion that the product is suitable for the purpose intended by the A/E. Such statements will not be acceptable unless they are signed by an officer of the manufacturer who is authorized to do so and unless the signature is certified by a notary public.
  - 2.2 Copy of the manufacturer's terms and conditions of sale with respect to:
    - A. Warranty on both products of its own manufacture and those manufactured by others but furnished as accessories and/or components;
    - B. Title and lien rights; and,
    - C. The manufacturer shall certify that he has thoroughly familiarized himself with the Owner's proposed use of, and installation arrangements for, his product, and that it is the manufacturer's opinion that the product is suitable for the purpose intended by the A/E.

- D. Any limitations on the manufacturer's liability, including that for patent infringement.
- 3 The equipment manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials when the equipment is subjected to normal use, operation, and service for a period on one (1) year following acceptance of the completed project by the Owner. Time of substantial completion will not be considered for the beginning of the warranty period.
- 4 The supplier shall also indicate in his submittal for approval of his equipment or product all dimensional, structural, mechanical, and electrical variations or deviations from the specifications or drawings of the item.
- 5 Furthermore, prior to shipment of pumps, the supplier shall submit the following for approval, if called for by the specifications sections concerning the pumping equipment:
- 5.1 A certified factory performance test curve for each pump supplied for this project shall be required. The certified performance test curve for each pump shall contain a minimum of eight (8) test points. These points shall have the following operating points: Shut-off, 50% of design flow, design flow, 125% of design flow and 150% of design flow. In addition to the certified factory performance test curve, provide additional information relating to each performance test as follows:
- 5.1.1 Summary of test equipment used.
- 5.1.2 Drive data, i.e., voltage, amperage, horsepower rpm, etc., for each test point.
- 5.1.3 The information for these tests shall be in tabular form listing all operating points. If the performance tests are conducted at an rpm other than the specified rpm, a table listing each operating point with its associated head, flow, horsepower, voltage, and amperage shall be provided along with the corresponding values adjusted to the specified rpm. The test rpms, if within a 5% range, shall be considered equal to that specified.
- 5.1.4 Serial number of each pump tested.
- 5.1.5 Manufacturer's statement that the pump being supplied has been hydro-statically tested to a pressure of 150% of the maximum pumping pressure obtainable by the pump with the largest impeller.

END OF SECTION

## SECTION 01310

### PROGRESS SCHEDULES

#### PART 1 GENERAL

##### 1.01 GENERAL

###### A. Scheduling Responsibilities

1. In order to provide a definitive basis for determining job progress, a construction schedule will be used to monitor the project. The schedule shall be of the Critical Path Method (CPM) or other method if approved by the ENGINEER in writing. The CONTRACTOR will be responsible for providing all information concerning the sequencing and durations of all activities. The CONTRACTOR will be required to provide analysis reports of the schedule and updated diagrams each month.
2. It should be clearly understood that the schedule and all revised information must be produced by the CONTRACTOR and that this information is a representation of the best efforts of the CONTRACTOR and his Subcontractors as to how they envision the work to be accomplished. Similarly, all progress information to be provided by and through the CONTRACTOR must be an accurate representation of his or his Subcontractor's or supplier's actual performance. The schedule shall at all times remain an accurate reflection of the CONTRACTOR'S actual or projected sequencing of the work. Once accepted by the OWNER, adherence to the established schedule shall be obligatory upon the CONTRACTOR and his Subcontractors for the work under this Contract.

###### B. Construction Hours

1. No work shall be done between 6:00 p.m. and 7:00 a.m. nor on Saturdays, Sundays or legal holidays

without the prior written permission of the OWNER. However, emergency work may be done without prior written permission.

2. If the CONTRACTOR, for his convenience and at his own expense, should desire to carry on his work at night or outside the regular hours, he shall submit a written request to the ENGINEER and shall allow nine (9) days for satisfactory arrangements to be made for inspecting the work in progress. If permission is granted, the CONTRACTOR shall light the different parts of the project as required to comply with all applicable Federal, State and local regulations. The CONTRACTOR shall also revise his schedule as appropriate at the next monthly schedule update meeting to reflect the changes in working hours.

C. Progress of the Work

1. The work shall be started within ten (10) days following the Notice to Proceed and shall be executed with such progress as may be required to prevent delay to other CONTRACTORS or to the general completion of the Project. The work shall be executed at such times and in or on such parts of the Project, and with such forces, material and equipment, to assure completion of the work in the time established by the Contract.
2. The CONTRACTOR agrees that whenever it becomes apparent from the current monthly schedule update that delays have resulted and, hence, that the Contract completion date will not be met or when so directed by the OWNER, he will take some or all of the following actions at no additional cost to the OWNER.
  - a. Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work.
  - b. Increase the number of working hours per shift, shifts per working day or days per

week, the amount of construction equipment, or any combination of the foregoing to substantially eliminate the backlog of work.

- c. Reschedule activities to achieve maximum practical concurrency of accomplishment of activities, and comply with the revised schedule.
- d. The CONTRACTOR shall submit to the OWNER for review a written statement of the steps he intends to take to remove or arrest the delay to the accepted schedule. If the CONTRACTOR should fail to submit a written statement of the steps he intends to take or should fail to take such steps as required by the Contract, the OWNER may direct the level of effort in manpower (trades), equipment, and work schedule (overtime, weekend and holiday work, etc.), to be employed by the CONTRACTOR in order to remove or arrest the delay to the critical path in the accepted schedule, and CONTRACTOR shall promptly provide such level of effort at no additional cost to the OWNER.

## 1.02 CONSTRUCTION SCHEDULE

### A. Requirements

- 1. The schedule shall show the order and interdependence of activities and the sequence in which the work is to be accomplished as planned by the CONTRACTOR. The diagrams will be followed to show how the start of a given activity is dependent on the completion of preceding activities and its completion restricts the start of following activities.
- 2. Detailed activities shall include, in addition to construction activities, the submittal and approval of samples of materials and shop

drawings, the procurement of material and equipment, fabrication of materials and equipment and their delivery, installation, and testing. The CONTRACTOR shall break the work into activities with durations of one to twenty (1 to 20) working days each, except for nonconstruction activities (such as procurement of materials and delivery of equipment) and other activities which may require longer durations. To the extent feasible, activities related to a specific physical area of the Project shall be grouped on the for ease of understanding and simplification. The selection and number of activities shall be subject to the review of the ENGINEER and the OWNER.

3. Each activity on the schedule shall have indicated for it the following:
  - a. A single duration (i.e., the single best estimate of the expected elapsed time considering the scope of the work involved in the activity) expressed in working days.
  - b. A brief description of the activity that will include the trade and/or Subcontractor as well as the structure and/or subsystem. If this description is not definitive, a separate listing of each activity and a descriptive narrative may be required.
  - c. Each activity shall be cost loaded to indicate the total estimated costs of the activity, including a prorated share of the estimated overhead and profit. Material costs shall be assigned to delivery activities. All estimated costs shall be in conformance with the schedule of payments as specified in the General Conditions and elsewhere in the Contract Documents. The estimated costs of all activities shall equal the Contract amount.

- d. Each activity shall be man-hour loaded with the estimated man-hours to be expended on each activity.
4. Failure to include on a schedule any element of work required for the performance of this Contract shall not excuse the CONTRACTOR from completing all work required within the applicable completion date, notwithstanding the schedule review by the ENGINEER or the OWNER.
5. A schedule which shows a completion of any portion of the construction work (not including testing and start-up) more than sixty (60) calendar days prior to the contractual completion date for that portion of the work may be accepted but in no event shall be acceptable as a basis for a claim for delay against the OWNER by the CONTRACTOR.

B. Submissions

1. Within ten (10) calendar days of the Notice to Proceed, the CONTRACTOR shall submit to ENGINEER five (5) prints of his proposed diagram for the entire contract duration. This initial diagram shall be drawn as described herein and submitted on sheets 24 inches x 36 inches. The schedule will be the subject of a schedule review meeting with the CONTRACTOR, the ENGINEER and the OWNER within one (1) week of its submission. The CONTRACTOR will revise and resubmit the schedule until it is acceptable and accepted by the OWNER. Failure by the CONTRACTOR to submit an acceptable schedule may, at the OWNER's sole discretion, be cause for the withholding of any partial payment(s) otherwise due the CONTRACTOR.
2. After final acceptance, the CONTRACTOR will deliver one reproducible mylar copy and five prints to the ENGINEER. This accepted schedule will be used for the duration of the Contract as the basis for evaluating the impact of changes and claims and will be modified to reflect the



actual progress of the CONTRACTOR.

3. The CONTRACTOR shall produce and deliver to the OWNER schedule reports detailing early and late start and finish dates, durations and floats. The CONTRACTOR will review the updated schedule reports and diagrams for accuracy and immediately report any errors.

### 1.03 SCHEDULE UPDATES

#### A. Monthly Meetings

1. A monthly Schedule Update Meeting will be held in conjunction with the applicable progress meeting at the construction site to review and update the CPM Schedule. The Schedule Update Meetings will be attended by the CONTRACTOR, the ENGINEER and the OWNER. Actual progress of the previous month will be recorded and future activities will be reviewed. The duration of activities and their logical connections may be revised as needed. No contractual completion dates will be modified without formal written requests and acceptance as specified herein.

#### B. Conditions Requiring Revisions are as follows:

1. When a delay in completion of any work item or sequence of work items results in an indicated extension of the project completion by thirty (30) days.
2. When delays in submittals or deliveries or work stoppages are encountered which make replanning or rescheduling of the work necessary.
3. When the schedule does not represent the actual prosecution and progress of the project.

### 1.06 CONTRACT COMPLETION TIME

#### A. Causes for Extensions

1. The Contract completion time will be adjusted only for causes specified in this Contract. In the event the CONTRACTOR requests an extension of any Contract completion date, he shall furnish such justification and supporting evidence as the OWNER may deem necessary for a determination as to whether the CONTRACTOR is entitled to an extension of time under the provisions of this Contract. The OWNER, with the assistance of ENGINEER, will, after receipt of such justification and supporting evidence, make findings of fact and will advise the CONTRACTOR in writing thereof. If the OWNER finds that the CONTRACTOR is entitled to any extension of the Contract completion date under the provisions of the Contract, the OWNER's determination as to the total number of days extension shall be based upon the currently accepted schedule and on all data relevant to the extension. Such data shall be included in the next monthly updating of the schedule. The CONTRACTOR acknowledges and agrees that actual delays in activities which, according to the schedule, do not affect any Contract completion date shown, do not have any effect on the Contract completion date or dates, and therefore, will not be the basis for a change in Contract completion time.

B. Requests for Time Extension

1. Each request for change in any Contract completion date shall be initially submitted to the OWNER within the time frame stated in the General Conditions. All information known to the CONTRACTOR at that time concerning the nature and extent of the delay shall be transmitted to the OWNER at that time. Within the time frame stated in the General Conditions but before the date of final payment under this Contract, all information as required above concerning the delay must be submitted to the OWNER. No time extension will be granted for requests which are not submitted within the foregoing time limits.

C. Adjustment by OWNER

1. From time to time it may be necessary for the Contract schedule and/or completion time to be adjusted to reflect the effects of job conditions, weather, technical difficulties, strikes, unavoidable delays, and other unforeseeable conditions which may indicate schedule adjustments and/or completion time extensions. Under such conditions, the OWNER shall direct the CONTRACTOR to reschedule the work to reflect the changed conditions, and the CONTRACTOR shall revise his schedule accordingly. Schedule extensions affecting the Contract completion time shall be granted only by the OWNER in writing. No additional compensation shall be made to the CONTRACTOR for such schedule changes except for unavoidable overall Contract time extensions beyond the actual completion of all unaffected work in this Contract, in which case the CONTRACTOR shall take all possible action to minimize any time extension and any additional cost to the OWNER. It is specifically pointed out that the uses of available float time in the CPM schedule may be used by the OWNER and his representatives as well as by the CONTRACTOR.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

PART 1. GENERAL

1.1 REQUIREMENTS INCLUDED

- A. General Quality Control.
- B. Workmanship.
- C. Manufacturers' Instructions.
- D. Manufacturers' Certificates.
- E. Mockups.
- F. Manufacturers' Field Services.
- G. Testing Laboratory Services.

1.2 RELATED REQUIREMENTS

- A. Section 00713 - General Conditions: Inspection and testing required by governing authorities.
- D. Section 01090 - Reference Standards: Applicability of specified reference standards.
- C. Section 01300 - Submittals: Submittal of Manufacturers' Instructions.
- D. Section 03301 - Concrete Work: Tests required for concrete.

1.3 QUALITY CONTROL, GENERAL

- A. Maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

1.4 WORKMANSHIP

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by utilizing only persons qualified to produce workmanship of specified quality.
- C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

#### 1.5 MANUFACTURERS' INSTRUCTIONS

- A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from A/E before proceeding.

#### 1.6 MANUFACTURERS' CERTIFICATES

- A. When required by individual Specification Sections, submit manufacturers' certificate, in duplicate, that products meet or exceed specified requirements.

#### 1.7 MOCKUPS

- A. When required by individual Specifications Section, erect complete, full-scale mockup of assembly at Project site. Tests will be performed in accordance with Section 01400, if applicable. Remove mockup at completion when approved by A/E.

#### 1.8 MANUFACTURER'S FIELD SERVICES

- A. When specified in respective Specification Sections, require supplier or manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship; start-up of equipment; test, adjust, and balance of equipment, as applicable; and, to make appropriate recommendations.
- B. Representative shall submit written report to A/E listing observations and recommendations.

#### 1.9 TESTING LABORATORY SERVICES

- A. Contractor shall employ and pay for services of an Independent Testing Laboratory to perform inspections, tests, and other services required by individual Specification Sections.
- B. Services will be performed in accordance with requirements of governing authorities or agencies and with specified standards.

- C Reports will be submitted to A/E in duplicate giving observations and results of tests, indicating compliance or non-compliance with specified standards and with Contract Documents.
- D Contractor shall cooperate with Testing Laboratory personnel; furnish tools, samples of materials, design mix, equipment, storage and assistance as requested.
  - 1. Notify A/E and Testing Laboratory at least 48 hours prior to expected time for operations requiring testing services.
  - 2. Make arrangements with Testing Laboratory and pay for additional samples and tests for Contractors' convenience.

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

NOT USED

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. Electricity, Lighting.
- B. Heat, Ventilation.
- C. Telephone Service.
- D. Water.
- E. Sanitary Facilities.
- F. Barriers.
- G. Enclosures.
- H. Protection of Installed Work.
- I. Water Control
- J. Cleaning During Construction.
- K. Project Identification.
- L. Field Offices and Sheds.

**1.2 RELATED REQUIREMENTS**

- A. Section 01031 - Special Project Procedures: Work sequence and Contractor's use of premises.
- B. Section 01710-Construction and Final Cleaning.

### 1.3 ELECTRICITY, LIGHTING

- A. Provide service required for construction operations, with branch wiring and distribution boxes located to allow service and lighting by means of construction-type power cords.
  - 1. Make arrangements for, pay deposits on, and install the poles, wiring, switches, outlets, and other electrical equipment necessary. The contractor shall contact the local electrical utility company as to coordinate the installation of the electrical service.
  - 2. Pay for current used during the construction period.
- B. Provide lighting for construction operations.
- C. Permanent lighting may be used during construction. Maintain lighting and make routine repairs.
- D. Remove temporary electrical equipment when construction is completed.

### 1.4 HEAT VENTILATION

- A. Provide as required to maintain specified conditions for construction operations and to protect materials and finishes from damage due to temperature or humidity. Follow any requirements set forth elsewhere in these specifications and as recommended by manufacture and supplier of equipment or products.
  - 1. Whenever fixtures, water services or items subject to damage from cold have been installed, maintain the temperature above 50 degrees F.
- B. Prior to operation of permanent facilities for temporary purposes, verify that installation is approved for operation, and that filters are in place. Provide and pay for operation, maintenance, utilities, and fully service all equipment including cleaning filters, at the time the building is turned over to the Owner.
- C. Provide ventilation of enclosed areas to cure materials, to disperse humidity, and to prevent accumulations of dust, fumes, vapors, or gases.
- D. No open fires will be permitted.

### 1.5 TELEPHONE SERVICE (Contract "A" Only)

- A. Provide telephone service to field office:



1. Listed with the information operator in the name of both the project and the Contractor.
2. Use limited to business calls.
3. Paid for by the Contractor.

#### 1.6 WATER

- A. Provide service required for construction operations. Extend branch piping with outlets located so that water is available by use of hoses.
  1. Make arrangements for, pay deposits on, and install the piping and equipment necessary.
  2. Pay for water used during the construction period.
- B. Remove temporary water facilities when construction is completed.

#### 1.7 SANITARY FACILITIES

- A. Provide and maintain required temporary facilities and enclosures for job personnel that:
  1. Are weather tight, clean and sanitary.
  2. Are provided with either natural light and ventilation or artificial light and mechanical ventilation.
  3. Are provided with toilet tissue in a suitable holder.
  4. Comply with applicable legal and health requirements.
- B. Remove temporary toilet facilities when work is complete. !
- C. Obtain permission from the Owner before allowing the use of facilities that have been permanently installed.

#### 1.8 BARRIERS

- A. Provide as required to prevent public entry to construction areas, to provide for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide barricades and covered walkways as required by governing authorities for public rights-of-way and for public access to existing building, if applicable.

- C. Provide barriers around trees and plants designated to remain. Protect against vehicular traffic, stored materials, dumping, chemically injurious materials, and puddling or continuous running water.

#### 1.7 ENCLOSURES

- A. Provide temporary weather-tight closures of openings in exterior surfaces to provide acceptable working conditions and protection for materials, to allow for temporary heating, and to prevent entry of unauthorized persons. Provide doors with self-closing hardware and locks.

#### 1.10 TEMPORARY ACCESS DRIVES

- A. Provide temporary surfacing for access to all construction areas. Methods and equipment are the Contractors option. Remove at the completion of the work.

#### 1.11 TEMPORARY CONTROLS

- A. Coordinate, schedule, and perform work to cause the least practical interference with the public, fire protection service, public utility service, and Owners operations. Coordinate all connections, cut-ins, alterations, or other interruption with designated representative of the Owner or utility service. Notify the representative 48 hours in advance and cooperate with him in minimizing the interruptions.
- B. Comply with the local requirements of EPA, OSHA, or other regulatory requirements for construction operations relating to noise, dust, safety, traffic, and pollution controls.

#### 1.12 PROTECTION OF INSTALLED WORK

- A. Provide temporary protection for installed products. Control traffic in immediate area to minimize damage.
- B. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings. Protect finished floors and stairs from traffic, movement of heavy objects, and storage.
- C. Prohibit traffic and storage on waterproofed and roofed surfaces, and on lawn and landscaped areas.

### 1.13 WATER CONTROL

- A. Grade sites to drain. Maintain excavations free of water. Provide and operate pumping equipment.

### 1.14 CLEANING DURING CONSTRUCTION

- A Construction cleaning shall be as specified in Section 01710.

### 1.15 PROJECT IDENTIFICATION

- A. Provide one (1) 8 feet X 4 feet by 3/4" thick Project identification sign of wood frame and exterior grade plywood construction, painted, with exhibit lettering by professional sign painter, to A/E's design and, bulletin colors (4 maximum). List title of Project, names of Owner, A/E, and Contractor. Sign detail is included with Standard Drawings.
- B. Erect on site at locations for each contract as directed by A/E.
- C. Allow no other signs to be displayed.
- D. Further detail of sign will be furnished by the A/E following contract award.

### 1.16 FIELD OFFICES AND SHEDS (Contracts "A" and "B" Only)

- A. Office: The Water Treatment Plant Contractors shall provide an office for himself, the A/E, and the Owner's representatives, which shall:
  - 1. Be located in an area approved by the A/E.
  - 2. Consist of a weathertight building or trailer of adequate size.
  - 3. Contain a desk or table, drawing rack, files, and chairs.
  - 4. Be provided with lights, heat, cooling, and ventilation.
  - 5. Be provided with a means of being locked.
  - 6. Be maintained in a neat and orderly manner.
- B. Storage Sheds for Tools, Materials, and Equipment: Weathertight with heat and ventilation for Products requiring controlled conditions, with adequate space for organized storage and access, and lighting for inspection of stored materials.

### 1.17 REMOVAL

- A. Remove temporary materials, equipment, services, and construction prior to Substantial Completion inspection.

- B. Clean and repair damage caused by installation or use of temporary facilities. Remove underground installations to a depth of two (2) feet; grade site as indicated. Restore existing facilities used during construction to specified or original condition.

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

NOT USED

END OF SECTION

## PART 1. GENERAL

## 1.1 DESCRIPTION

- A. This work shall consist of erosion control on all cut and fill operations, excavation, backfill, or other construction activities within the limits of the construction site, within any temporary or permanent easements, and within any borrow site used during the period of construction. The contractor shall submit an erosion control plan for review and approval prior to commencement of any construction activities. The contractor shall also file a Notice of Intent with the  
prior to commencement of work of each contract and adhere to the requirements of this permit. Protection of these sites shall continue throughout the construction period. During flood seasons, protect the sites by sandbagging, pumping of water, and any other means appropriate to restrain flooding of existing work and equipment. During dry weather, sprinkle the sites with water or use other means as necessary to provide dust control. In case of abnormally cold weather, any construction such as excavation work may be delayed until warmer weather or covered to prevent freezing.
- B. The temporary pollution control provisions contained, herein shall be coordinated with the permanent erosion control features, to ensure economical, effective, and continuous erosion control throughout the construction and post-construction period.

## PART 2. PRODUCTS

## 2.1 TEMPORARY BERMS

- A. A temporary berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes or transverse to centerline on fills.
- B. These berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.

- 2.2 TEMPORARY SLOPE DRAINS: A temporary slope drain is a facility consisting of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half round pipe, metal pipe, plastic pipe, sod, or other material that may be used to carry water down slopes to reduce erosion.

- 2.3 SEDIMENT STRUCTURES: Sediment basins, ponds, and traps, are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect properties and stream channels below the construction areas from excessive siltation.
- 2.4 CHECK DAMS: Check dams are barriers composed of large stones, sand bags, or other non-erodible materials placed across or partially crossing a natural or constructed drainway.
- 2.5 TEMPORARY SEEDING AND MULCHING: Temporary seeding and mulching are measures consisting of seeding, mulching, fertilizing, and matting utilized to reduce erosion. All cut and fill slopes including waste sites and borrow pits shall be seeded when and where necessary to eliminate erosion.
- 2.6 STAKED BALED HAY OR STRAW CHECKS
- A. Staked baled hay or straw erosion checks are temporary measures to control erosion and prevent siltation. Bales shall be either hay or straw containing 5 cubic feet or more of material and staked in place as to prevent movement during water flow.
  - B. Baled hay or straw checks shall be used where the existing ground slopes toward or away from the embankment along the toe of slopes, in ditches, or other areas where siltation erosion or water runoff is a problem.
- 2.7 TEMPORARY SILT FENCES: Silt fences are temporary measures utilizing woven wire or other approved material attached to posts with filter cloth composed of burlap, plastic filter fabric, etc., attached to the upstream side of the fence to retain the suspended silt particles in the runoff water.

### PART 3. EXECUTION

- 3.1 PROJECT REVIEW: Prior to the Preconstruction Conference the Contractor shall meet with the A/E and go over in detail the expected problem areas in regard to the erosion control work. Different solutions should be discussed so that the best method might be determined. It is the responsibility of the Contractor to develop an erosion control plan that is acceptable to the A/E. The erosion control plan shall be submitted at the Preconstruction Conference. The A/E shall review for approval or revisions and resubmit to the contractor as to allow for installation of measures prior to any construction activities and/or excavation.
- 3.2 The project drawings show the minimum erosion and siltation control measures required for this job. It is the responsibility of the contractor to install any and all erosion measures necessary to prevent erosion and sediment runoff.

- 3.3 The contractor shall take special care in installing and maintaining erosion control devices adjacent to and along

The contractor shall also provide all necessary erosion control measures and devices as indicated in all regulatory permits such as the Corp of Engineers 404 Permit

and for the NPDES Permit (for work at the Water Treatment Plant backwash lagoons).

- 3.4 If the Contractor desires to stockpile construction materials, stone, earth, etc., the location of it and protection thereof shall be outlined in an Erosion and Siltation Control Plan to be submitted to the A/E for review and approval.

- 3.5 The Contractor shall submit a spill prevention plan to the A/E for review. The contents of this spill prevention plan shall depend on what types of chemicals, lubricants and fuels will be used and if these will be stored on site. As a minimum, if no fuel or lubricants or other chemicals are stored on site, either temporarily in vehicular tanks or in skid or trailer mounted tanks, a plan shall be supplied which directs all employees of the Contractor in the proper procedures to be followed should a spill occur. For more complex chemical storage requirements, a more complex plan will be required.

- 3.6 PRECONSTRUCTION CONFERENCE: At the Preconstruction Conference, the Contractor shall submit for acceptance his schedule for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, bridges, and other structures at watercourses, construction, and paving. He shall also submit for acceptance his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the A/E.

3.7 CONSTRUCTION REQUIREMENTS

- A. The A/E has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface of erodible earth material exposed by excavation, borrow and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats seeding or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds to the extent directed by the ENGINEER. The embankment area at the embankment area' at the end of the proposed lagoon shall be protected at all phases of construction and shall be

immediately stabilized with rip-rap / shot rock large enough to stabilize the bank (12-inch minimum).

- B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures shall be used to correct conditions that develop during construction that were not foreseen during the preconstruction stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.
- C. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise erosion control measures may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing, exceed 750,000 square feet.
- D. The A/E will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, -mulching\* seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- E. The A/E may decrease the amount of surface area or erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by his analysis of project conditions.
- F. In the event of conflict between these requirements and pollution control laws, rules or regulations, or other Federal, State, or Local agencies, the more restrictive laws, rules, or regulations shall apply.

### 3.6 CONSTRUCTION OF STRUCTURES

#### A. Temporary Berms

- 1. A temporary berm shall be constructed of compacted soil, with a minimum width of 24 inches at the top and a minimum height of twelve (12) inches, with or without a shallow ditch, constructed at the top of fill slopes or transverse to centerline on fills. Temporary berms shall be graded so as to drain to a compacted outlet at a slope drain.



2. When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed, and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural or intended condition.

D. Check Dams

1. Check dams shall be utilized to retard \*stream flow or restrict stream flow within the channel. Materials utilized to construct check dams are varied and should be clearly illustrated or explained in the Contractor's erosion control plan.
2. All check dams shall be keyed into the sides and bottom of the channel. A design is not needed for check dams.

- E. Temporary Seeding and Mulching: Seeding and mulching shall be performed in accordance with the Section 02485 Seeding.

- F. Baled Hay or Straw Erosion Checks: Hay or straw erosion checks shall be embedded in the ground four (4) to six (6) inches to prevent water flowing under them. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the A/E. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris cleanout will be considered routine maintenance.

G. Temporary Silt Fences

1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill slopes, in ditches, or other areas where siltation is a problem. Silt fences are constructed of wire mesh fence with a covering of burlap or some other suitable material on, the upper grade side of the fence and anchored into the soil.
2. The Contractor shall be required to maintain the silt fence in a satisfactory condition for the duration of the project or until its removal is requested by the A/E. The silt accumulation at the fence may be left in place and seeded, removed, etc., as directed by the A/E. The silt fence becomes the property of the Contractor whenever the fence is removed.

- H Under no circumstances will spent oil wastes be discharged anywhere on the site.

3.7 MAINTENANCE

The area adjacent to the temporary berm in the vicinity of the slope drain must be properly graded to enable this inlet to function efficiently and with only minimum ponding in this area. All transverse berms required on the downstream side of a slope drain shall extend across the grade to the highest point at approximately a ten- (10) degree angle with a perpendicular to centerline. The top width of these berms may be wider and the side slope flatter on transverse berms to allow equipment to pass over these berms with minimal disruptions. When practical and until final roadway elevations are approached, embankments should be constructed with a gradual slope to one side of the embankment to permit the placement of temporary berms and slope drains on only one side of the embankment.

**B. Temporary Slope Drains**

1. Temporary slope drains shall consist of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half round pipe, metal pipe, plastic pipe, flexible rubber, or other materials which can be used as temporary measures to carry water accumulating in the cuts and on the fills down the slopes prior to installation of permanent facilities or growth of adequate ground cover on the slopes.
2. Fiber matting and plastic sheeting shall not be used on slopes steeper than 4:1 except for short distances of 20 feet or less.
3. All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base for temporary slope drains shall be compacted and concavely formed to channel the water or hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain. Energy dissipaters, sediment basins, or other approved devices shall be constructed at the discharge end of the slope drains to reduce erosion downstream. An ideal dissipater would be dumped rock or a small sediment basin, which would slow the water as well as pick up some sediment. All temporary slope drains shall be removed when no longer necessary and the site restored to match the surroundings.

**C. Sediment Structures**

1. Sediment structures shall be utilized to control sediment at the foot of embankments where slope drains discharge; at the bottom as well as in the ditch lines atop waste sites; in the ditch lines or borrow pits. Sediment structures may be used in most drainage situations to prevent excessive siltation of pipe structures. All sediment structures shall be at least twice as long as they are wide.

- A. The temporary erosion control features installed by the Contractor shall be acceptably maintained by the Contractor until no longer needed or permanent erosion control methods are installed. Any materials removed shall become the property of the Contractor.

3.8 EROSION CONTROL OUTSIDE PROJECT AREA: Temporary pollution control shall include construction work outside the project area where such work is necessary as a result of construction such as borrow pit operations, haul roads, and equipment storage sites.

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. Products.
- B. Transportation and Handling.
- C. Storage and Protection.
- D. Product Options.
- E. Products List.
- F. Substitutions.
- G. Systems Demonstration

**1.2 RELATED REQUIREMENTS**

- A. Section 00140 - Information for Bidders: Times for submittal of requests for substitutions during the bidding period.
- B. Section 00713 - General Conditions.
- C. Section 01031 - Special project procedures
- D. Section 01040 - Coordination: Coordination of construction.
- E. Section 01090 – Reference standards.
- F. Section 01300 - Submittals: Product data submittals and shop drawings.
- G. Section 01400 - Quality Control: Submittal of manufacturers' certificates.
- H. Section 01700 - Contract Closeout: Operation and maintenance data; warranties and bonds; record documents.

**1.3 QUALITY ASSURANCE**

A. Approval Required

1. The contract is based on the standards of quality established in the contract documents.
2. All products proposed for use, including those specified by required attributes and performance shall require approval by the A/E before being incorporated into the work.

B. "Or Equal"

1. Where the phrase "or equal" or "or approved equal" occurs in the contract documents, do not assume that materials, equipment, or methods will be approved as equal unless the item has been specifically approved for this work by the A/E.
2. The decision of the A/E shall be final.
3. See pertinent portions of the contract documents for additional information relating to substitutions.

1.4 PRODUCTS

- A. Products include material, equipment, and systems.
- B. Comply with Specifications and referenced standards as minimum requirements.
- C. Components required to be supplied in quantity within a Specification section shall be the same, and shall be interchangeable:

1.5 TRANSPORTATION AND HANDLING

- A. Transport products by such methods that will avoid product damage; deliver in undamaged condition in manufacturer's unopened containers or packaging, dry.
- B. Provide equipment and personnel to handle products by methods to prevent soiling or damage.
- C. Promptly inspect shipments to assure that products comply with requirements that quantities are correct, and that products are undamaged.

1.6 STORAGE AND PROTECTION

- B. Store products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight enclosures; maintain within temperature and humidity ranges required by manufacturer's

instructions. Protect all equipment, electrical controls, and project components from adverse weather and water damage at all times throughout the project.

- C. For exterior storage of fabricated products, place on sloped supports above ground. Cover products subject to deterioration with impervious sheet covering; provide ventilation to avoid condensation.
- D. Store loose granular materials on solid surfaces in a well-drained area; prevent mixing with foreign matter.
- D. Arrange storage to provide access for inspection. Periodically inspect to assure products are undamaged, and are maintained under required conditions. Schedule delivery of equipment and construction components as to prevent outside storage for an extended period that may cause weathering or damage.

#### 1.7 PRODUCT OPTIONS

- A. Products specified by reference standards or by description only: Supply products meeting those standards.
- B. Products specified by naming one or more manufacturers with a provision for substitutions: Submit a request for substitution for any manufacturer not specifically named. The A/E may reject or approve based on his review.
- C. Products specified by naming several manufacturers: Supply products of named manufacturers meeting specifications: No options, no substitutions allowed.
- D. Products specified by naming only one manufacturer No options, no substitutions allowed.

#### 1.8 PRODUCTS LIST

- A. Within 7 days after date of Owner-Contractor Agreement, or as established in Notice-to-Proceed, submit complete list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.

#### 1.9 SUBSTITUTIONS

- A. During bidding period, Instructions to Bidders govern times for submitting requests for substitutions under requirements specified in this Section.
- B. Only within twenty (20) days after date of Owner-Contractor Agreement or established in Notice-to-Proceed shall A/E consider requests from Contractor for substitutions. Subsequently, substitutions will be considered only when a product becomes unavailable due to no fault of Contractor. Confirmation of unavailable products must be in writing and certified by the

manufacturer that the product is no longer available. No additional cost will be allowed for products that are requested to be substituted, based on the unavailability of the specified product and/or model.

- C Submit separate request for each substitution. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.
- D Request constitutes a representation that Contractor:
  - 1 Has investigated proposed product and determined that it meets or exceeds, in all respects, specified product.
  - 2 Will provide the same warranty for substitution as for specified product.
  - 3 Will coordinate installation and make other changes that may be required for work to be complete in all respects.
  - 4 Waives claims for additional costs that may subsequently become apparent.
- E Substitutions shall not be considered when they are indicated or implied on shop drawing or product data submittals. Separate written request must be submitted for any proposed substitutions or deviation from the Contract Documents.
- F A/E shall determine acceptability of proposed substitution, and shall notify Contractor of acceptance or rejection in writing within a reasonable time.
- G Substitute products shall not be ordered or installed without written acceptance.
- H Only one request for substitution shall be considered for each product. When substitution is not accepted, provide specified product.
- I A/E shall determine acceptability of substitutions.

#### 1.10 SUBMITTAL PROCEDURES

- A. Submit two copies of request for substitution.
- B. A/E shall review Contractor's requests for substitutions with reasonable promptness.
- C. During the bidding period, A/E shall record acceptable substitutions, if any, in Addenda.
- D. After award of Contract, A/E shall notify Contractor, in writing, of decision to accept or reject requested substitution within 15 days.
- E. For accepted products, submit shop drawings, product data, and samples under provisions of Section 01300.

1.11 SYSTEMS DEMONSTRATION

- A. Prior to final inspection, demonstrate operation of each system to the Owner.
- B. Instruct Owner's personnel in operation, adjustment, and maintenance of equipment and systems, using the operation and maintenance data as the basis of instruction.

PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

NOT USED

END OF SECTION



## PART 1. GENERAL

### 1.1 REQUIREMENTS INCLUDED –

- A. Closeout Procedures.
- B. Final Cleaning.
- C. Project Record Documents.
- D. Operation and Maintenance Data.
- E. Warranties and Bonds.
- F. Spare Parts and Maintenance Materials.

### 1.2 RELATED REQUIREMENTS

- A. Section 00713 - General Conditions: Fiscal provisions, legal submittals, and other administrative requirements.
- B. Section 01710 - Construction and Final Cleaning.

### 1.3 CLOSEOUT PROCEDURES

- A. Comply with procedures stated in General Conditions of the contract and procedures specified in this Section for issuance of Certificate of Substantial Completion.
- B. Owner will occupy designated portion of Project for the purpose of installation of Owner furnished equipment, or conduct of business, under provision stated in Certificate of Substantial Completion.
- C. When Contractor considers work has reached final completion, 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 A/E's inspection.

- D. In addition to submittals required by the conditions of the contract, provide submittals required by governing authorities, and submit a final statement of accounting, giving total adjusted Contract Sum, previous payments, and sum remaining due.
- E. A/E will issue a final Change Order reflecting approved adjustments to Contract Sum not previously made by Change Order.

#### 1.4 SUBSTANTIAL COMPLETION

- A. When Contractor considers work or designated portion of work is substantially complete, submit written notice with list of items to be completed or corrected.
- B. Should A/E inspection find work is not substantially complete, he will promptly notify Contractor in writing, listing observed deficiencies.
- C. Contractor shall remedy deficiencies and send a second written notice of substantial completion.
- D. When A/E finds work is substantially complete, he will prepare a Certificate of Substantial Completion in accordance with provisions of General Conditions.

#### 1.5 FINAL COMPLETION

- A. When Contractor considers work is complete, submit written certification that:
  - 1. Contract Documents have been reviewed.
  - 2. Work has been inspected for compliance with Contract Documents.
  - 3. Work has been completed in accordance with Contract Documents, and deficiencies listed with Certificate of Substantial Completion have been corrected.
  - 4. Equipment and systems have been tested, adjusted, and balanced, and are fully operational.
  - 5. Operation of systems has been demonstrated to Owner's personnel.
  - 6. Work is complete and ready for final inspection.
- B. Should A/E inspection find work incomplete, he will promptly notify Contractor in writing listing observed deficiencies.
- C. Contractor shall remedy deficiencies and send a second certification of final completion.
- D. When A/E finds work is complete, he will consider closeout submittals.

#### 1.6 REINSPECTION FEES

- A. Should status of completion of work require reinspection by A/E due to failure of work to comply with Contractor's claims on initial inspection, the Contractor will reimburse the A/E compensation for reinspection services for the sum of three hundred dollars no cents (\$300) per person for each requested reinspection trip.

## 1.7 CLOSEOUT SUBMITTALS

- A. Before issuance of Certificate of Payment for Final Payment, deliver to the A/E the following:
  - 1. Evidence of Compliance with Requirements of Governing Authorities:
    - A. Certificate of Occupancy.
    - B. Certificates of Inspection required for mechanical and electrical systems.
  - 2. Project Record Documents:
    - A. Store documents separate from those used for construction.
    - B. Keep documents current; do not permanently conceal any work until required information has been recorded.
    - C. At contract closeout, submit documents with: transmittal letter containing dates, project title, Contractor's name and address, list of documents, and signature of Contractor. One set of clean blue-line drawings with revisions neatly marked in red shall be submitted to the A/E. Final project closeout will not be authorized until these record drawings have been submitted to the A/E.
  - 3. Operation and Maintenance Data:
    - A. Provide data for
      - a. Treatment Equipment - Division 11.
      - b. Mechanical Equipment and Controls-Division 15.
      - c. Electrical Equipment and Controls-Division 16.
      - d. All other equipment, pumps, controls, ventilation/heating/cooling equipment, valves, analyzers, flow meters, pressure transmitters, access doors, electrically operated doors, roofing system, block and finishes selection, paint selections, cabinets/lab furnishings, lab equipment, windows, doors, backup generators, chemical feed equipment, chlorine safety equipment, SCADA system and

telemetry system.

- B. Submit two (2) sets prior to final inspection, bound in 8 ½ inch by 11 inch 3-ring side binders with durable plastic covers.
- C. Provide a separate volume for each system, with a table of contents and index tabs for each volume.
- D. Part 1: Directory, listing names, addresses, and telephone numbers of: A/E and Contractor.
- E. Part 2: Operation and maintenance instructions, arranged by Specification Division. For each Specification Division, give names, address, and telephone numbers of subcontractors and suppliers.

List:

- a. Appropriate design criteria.
- b. List of equipment.
- c. Parts list.
- d. Operating instructions.
- e. Maintenance instructions, equipment.
- f. Maintenance instructions, finishes,
- g. Shop drawings and product data. h. Warranties.

#### 4 WARRANTIES AND BONDS

- A. Provide duplicate, notarized copies. Execute Contractor's submittals and assemble documents executed by subcontractors, suppliers, and manufacturers. Provide table of contents and assemble in binder with durable plastic cover.
- B. Submit material prior to final application for payment. For equipment put into use with Owner's permission during construction, submit within fifteen (15) days after first operation. For items of work delayed materially beyond Date of Substantial Completion, provide updated submittal within ten (10) days after acceptance, listing date of acceptance as start of warranty period.

#### 5 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, and maintenance materials in quantities specified in each Section, in addition to that used for construction of work. Coordinate with Owner, deliver to Project site and obtain receipt prior to final payment.

#### 6 Keys and keying schedule: under provisions of section 08700.

7. Evidence of Payment and Release of Liens: Waivers of Lien in accordance with Conditions of the contract; AIA Document G706A.
8. Affidavit of Payment of Debts and Claims: AIA Document G706.
9. Consent of Surety to Final Payment: AIA Document G707.
10. Certificates of Insurance for Products and Completed Operations: In accordance with Supplementary Conditions.
11. Three (3) certified copies of all submittal data, each copy neatly bound in a three (3) ring binder.
12. All Certificates of Compliance specified in Section 01300, as a condition of acceptance of the work.
13. Make submittals in strict accordance with the provisions of this Section.

#### 1.8 STATEMENT OF ADJUSTMENT OF ACCOUNTS

- A. Submit final statement reflecting adjustments to Contract Sum indicating:
  1. Original Contract Sum.
  2. Previous change orders.
  3. Changes under allowances, if applicable.
  4. Changes under unit price, if applicable.
  5. Deductions for uncorrected work.
  6. Penalties and bonuses.
  7. Deductions for liquidated damages.
  8. Other adjustments to Contract Sum.
  9. Total Contract Sum as adjusted.
  10. Previous payments.
- B. A/E will issue a final Change Order reflecting approved adjustments to Contract Sum not previously made by change orders.

#### 1.9 APPLICATION FOR FINAL PAYMENT

- A. Submit application for final payment in accordance with provisions of the General Conditions of the contract.

### PART 2. PRODUCTS

NOT USED

PART 3. EXECUTION

NOT USED

END OF SECTION

PART1 GENERAL

1.1 REQUIREMENTS INCLUDED

- A. Cleaning and disposal of waste materials, debris, and rubbish during construction.
- B. Final cleaning of exterior and interior of project.

1.2 RELATED REQUIREMENTS

- A. Section 00713 - General Conditions: Cleaning Up.
- B. Section 01700 - Contract Closeout: Closeout procedures
- C. Individual Specifications Sections: Specific cleaning for product or work.

1.3 DESCRIPTION

- A. Work Included: Throughout the construction period, maintain the building(s) and site in a standard of cleanliness as described in this section.
- B. Execute cleaning prior to inspection for Substantial Completion of the work.

1.4 QUALITY ASSURANCE

- A. Inspection: Conduct inspection daily, and more often if necessary, to verify that requirements for cleanliness are being met.
- B. Codes and Standards: In addition to the standards described in this Section, comply with all pertinent requirements of government agencies having jurisdiction.

PART 2. PRODUCTS

2.1 EQUIPMENT

- A. Provide covered containers for deposit of waste materials, debris, and rubbish.

## 2.2 CLEANING MATERIALS AND EQUIPMENT

- A. Provide all required personnel, equipment, and materials needed to maintain the specified standard of cleanliness.
- B. Use materials which will not create hazards to health or property, and which will not damage surfaces.

## 2.3 COMPATIBILITY

- A. Use only materials, equipment, and methods on surfaces being cleaned as recommended by manufacturer of material being cleaned, or as approved by A/E.

# PART 3. EXECUTION

## 3.1 CONSTRUCTION CLEANING

### A. General

- 1. Retain all stored items in an orderly arrangement allowing maximum access, not impeding drainage or traffic, and providing the required protection of materials.
- 3. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to closing the space.
- 3. Control cleaning operations so that dust and other particulates will not adhere to wet or newly coated surfaces.

### B. Disposal:

- 1. Remove waste materials, debris, and rubbish from site bi-monthly and dispose of off-site.
- 2. For items awaiting disposal, observe all requirements for protection of the ecology.

### C. Site:

- 1. Daily, and more often if necessary, inspect the site and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.



2. Weekly, and more often if necessary, inspect all arrangements of materials stored on the site. Restack, tidy, or otherwise service all arrangements to meet the requirements of 3.1 A1.
3. Maintain the site in a neat and orderly condition at all times.

D Structures:

1. Weekly, and more often if necessary, inspect the structures and pick up all scrap, debris, and waste material. Remove all such items to the place designated for their storage.
2. Weekly, and more often if necessary, sweep all interior spaces clean. "Clean," for the purposes of this paragraph, shall be interpreted as meaning free from dust and other material capable of being removed by use of reasonable effort and a hand held broom.
3. As required preparatory to the installation of succeeding materials, clean the structures or pertinent portions thereof to the degree of cleanliness recommended by the manufacturer of the succeeding material, using all equipment and materials required to achieve the required cleanliness.
4. Following the installation of finish floor materials, clean the finish floor daily (and more often if necessary) at all times while work is being performed in the space in which finish materials have been installed. "Clean," for the purpose of this paragraph, shall be interpreted as meaning free from all foreign material that, in the opinion of the A/E, may be injurious to the finish floor material.

### 3.2 FINAL CLEANING

- A. Definition: Except as otherwise specifically provided, "clean" (for the purpose of all paragraphs under 3.2) shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.
- B. General:
  1. Prior to the completion of the work, remove from the job site all tools, surplus materials, equipment, scrap, debris, and waste. Conduct final construction cleaning as described under 3.1, above.
  2. Remove temporary protection and labels not required to remain.
  3. Clean transparent and glossy materials to a polished condition; remove foreign substances. Polish reflective surfaces to a clear shine.
  4. Vacuum clean carpeted and similar soft surfaces.

5. Clean, damp mop, wax, and polish resilient and bare surfaced floor as specified.
  6. Clean surfaces of equipment; remove excess lubrication.
  7. Clean plumbing fixtures to a sanitary condition.
  8. Clean permanent filters of ventilating equipment and replace disposable filters when units have been operated during construction; in addition, clean ducts, blowers, and coils when units have been operated without filters during construction.
  9. Clean light fixtures and lamps.
  10. Maintain cleaning until Substantial Completion or agreed upon date of Owner occupancy.
  11. Remove waste, foreign matter, and debris from roofs, gutters, area ways, and drainage systems.
  12. Remove waste, debris, and surplus materials from site. Clean grounds; remove stains, spills, and foreign substances from paved areas and sweep clean. Rake clean other exterior surfaces.
- C Site: Unless otherwise specifically directed by the A/E, broom clean all paved areas on the site and all public paved areas directly adjacent to the site. Completely remove all resultant debris.
- D Structure
1. Exterior: Visually inspect all exterior surfaces, and remove all traces of soil, waste material, smudges, and other foreign matter. Remove all traces of splashed materials from adjacent surfaces. If necessary to achieve a uniform degree of exterior cleanliness, hose down the exterior of the structure. In the event of stubborn stains not removable with water, the A/E may require light sandblasting or other cleaning at no. additional cost to the Owner.
  2. Interior: Visually inspect all interior surfaces, and remove all traces of soil, waste material, smudges, and other foreign matter. Remove all traces of splashed materials from adjacent surfaces. Remove all paint droppings, spots, stains, and dirt from finished surfaces. Use only the specified cleaning materials and equipment.

3. Glass: Clean all glass inside and outside.
4. Polished Surfaces: To all surfaces requiring the routine application of buffed polish, apply the polish recommended by the manufacturer of the material being polished.

E Timing: Schedule final cleaning as approved by the A/E to enable the Owner to accept a completely clean project.

### 3.8 CLEANING DURING THE OWNER'S OCCUPANCY!

- A. Should the Owner occupy the work or any portion thereof prior to its completion by the Contractor and acceptance by the Owner, responsibilities for interim and final cleaning of the occupied spaces shall be as determined by the A/E in accordance with the General Conditions.

END OF SECTION

## PART 1. GENERAL

- 1.1 Disinfect all new water lines, clarifiers, filters and appurtenances, clearwell, storage tanks, pumps, and all other new equipment as well as all such existing units that are likely to be contaminated due to construction activities and that are designed to remain in contact with potable water.
- 1.2 Use a chlorine solution for this disinfection, flush clean with potable water, and sample the flushed water for bacteriological testing.

## PART 2. PRODUCTS

Use either of the following chemicals to prepare the disinfecting solution:

- 2.1 High test hypochlorite (**65%** to **70%** available chlorine) meeting the requirements of AWWA B300.
- 2.2 Liquid chlorine meeting the requirements of AWWA B301.

## PART 3. EXECUTION

- 3.1 Disinfection: Prepare a chlorine solution with a strength of not less than 50 mg/l. If high test hypochlorite is dissolved, avoid using the insoluble residues by decanting the cleaner solution from the top. Fill the unit or units being treated with the chlorine solution, and allow the solution to remain in contact for a minimum of 24 hours. After 24 hours, the chlorine solution shall have chlorine concentration of not less than 25 mg/l throughout the unit.
- 3.2 Flushing: At the end of the contact period, thoroughly flush the water lines, basins, etc., using potable water with a chlorine residual of 1.0 mg/l until the chlorine residual drops to less than 2.0 mg/l.
- 3.3 Sampling: Following flushing, collect not less than two (2) samples for bacteriological analysis, and deliver to an approved laboratory. Place the plant into service upon obtaining satisfactory results of such examination. Should unsatisfactory results be obtained, repeat this process until the results are satisfactory.

END OF SECTION

## **SECTION 01730 – Instruction to Owner for Operation and Maintenance**

The Contractor shall furnish, at his own expense, the services of a factory trained serviceman to instruct the Owner's personnel in the operation and maintenance of the equipment, including the calibration and adjustment of each item of equipment. This service shall be furnished in accordance with the paragraph of Section 01031, Special Project Procedures, entitled "Operation and Maintenance" for at least the number of days specified below, with additional time furnished if called for elsewhere in these specifications.

SPECIFICATION SECTION	DESCRIPTION	NUMBER OF DAYS
11236	Vertical Turbine Pumps	2
	Contract "A" Water Treatment	2
11320	Sludge Blanket Clarifier	2
11321	Filtration System	2
11355	Chlorination Equipment	2
11356	Chemical Feed Equipment	2
	Contract "A" Water Treatment Plant	1
13600	Instrumentation & Controls	2
16900	SCADA	2

END OF SECTION

<p style="text-align: center;"><b>PROJECT MANUAL</b> <b>TECHNICAL SPECIFICATIONS</b></p>
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**THE CITY OF GREENUP**  
**2018 WATER TREATMENT PLANT**

**The City of Greenup**

1005 Walnut Street  
Greenup, KY 41144  
(606) 473 – 7331

Lundie Meadows – Mayor  
David Black – City Council  
Steve Branim – City Council  
Kathy Newberry – City Council  
Mark Harris – City Council  
Bruce Mantz – City Council  
Marty Stephens – City Council

**Howerton Engineering & Surveying PLLC**

Richard L. Howerton, PE, PLS, CFM  
404 Main Street  
Greenup, KY 41144  
(606) 473 - 5684

<p><b>The City of Greenup</b></p>
-----------------------------------

<p>Approved: _____</p> <p>Title: _____</p> <p>Date: _____</p>
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PART 1. GENERAL

- 1.1 A subsurface investigation was made for the A/E's use during design for Contract A (Water Treatment Plant. See the Geotechnical Report located within the Appendix of these Specifications.
- 1.2 Any Bidder requiring additional subsurface information may perform his own independent test drilling, borings or probing at the Water Treatment Plant. Coordinate such pre-bid testing with the A/E and the Owner.
- 1.3 Any material to be excavated, including rock excavation and offsite disposal, shall be considered unclassified and no extra pay item will be allowed for this work. This work shall be considered incidental to the project costs as shown in the Bid Form. Excavate to the elevations indicated by the drawings.
- 1.4 Employ a qualified, experienced, and independent testing laboratory to provide quality control for all borrow and fill operations. Provide at least two compaction tests for each lift of compacted fill material for the Water Treatment Plant two compaction tests for every 10,000 square feet or portion thereof for each lift of compacted fill outside the building. Submit copies of all tests as specified elsewhere and one additional copy to the Owner.

PART 2. PRODUCTS

Not used.

PART 3. EXECUTION

Not used.

END OF SECTION

## PART 1. GENERAL

- 1.1 This work consists of clearing, grubbing, removing, and offsite disposal of all debris and of all vegetation, buildings, and foundations not removed by others that are within designated construction areas, easements, and temporary construction easements except for such objects that the A/E designates to remain. This work shall include Water Treatment Plant site to allow proper construction and installation of components. The work shall also include preserving and protecting from injury or defacement all vegetation and objects designated to remain. '
- 1.2 The A/E will designate all trees, shrubs, plants, and other items that are to remain. Paint required **for** cut or scarred surfaces **of** trees or shrubs selected **for** retention shall be an asphaltum base paint prepared especially for tree surgery and approved by the A/E.

PART 2. PRODUCTS  
Not Used

## PART 3. EXECUTION

- 3.1 Clear the entire construction area of all weeds, brush, briars, bushes, trees, stumps, and other protruding obstructions not designated to remain, except within any areas which the A/E may designate to remain undisturbed.
- 3.2 Perform all clearing and grubbing operations in accordance with the applicable provisions for erosion control as shown on the drawings and as required by local authorities.
- 3.3 Completely dispose of all materials resulting from clearing and grubbing off the site or at a location approved by the A/E.

END OF SECTION

PART 1. GENERAL

- 1.1 This work shall consist of the excavation and backfill or disposal of all materials required for the construction of structures for which excavation is not otherwise provided, in accordance with these specifications and in reasonably close conformity with the lines, grades, and typical cross sections shown on the drawings. The work specified in this section includes removing and satisfactorily disposing of all materials of whatever nature encountered in the excavation necessary for the construction of the foundations, clearwell walls, wetwell walls, and all other components for all structures and the intake pipe and foundation pad; this work shall include all pumping, bailing, and draining; it shall also include the necessary construction and subsequent removal of all cribs, cofferdams, or caissons; the replacement of backfill to the original ground level; the disposal of surplus materials; and final clean-up. This work shall include incidentals such as construction and subsequent removal of a sediment trap/ filtration basin to allow pumping of the ground water into the sediment trap/filtration basin prior to discharge back to receiving body (in accordance with the appropriate regulatory requirements).
- 1.2 CLASSIFICATION: Excavation for structures shall be considered unclassified. Unclassified structure excavation shall include all excavation regardless of the materials encountered and shall be considered incidental to work outlined within the project Bid Form in which no additional pay item will be allowed for this work.

PART 2. PRODUCTS

Not Used.

PART 3. EXECUTION'

3.1 GENERAL

- A Remove all material to the full depth of the foundation, and use it for backfilling, placing in embankments, stabilizing and protecting the embankment, stabilizing and protecting, backfilling subgrade of the access road, backfilling berms of the backwash lagoons at the Water Treatment Plant or dispose excess materials offsite. Any material used for backfilling, stabilizing and for the access road subgrade shall be approved by the A/E prior to placement.

- B. Cut all excavation true to alignment and grade without rounded corners and edges, and allow no projections of any kind to extend into the neat lines of the structures.

### 3.2 FOOTING EXCAVATION

- A. Whenever practicable, construct all substructures in open excavation. Shore, brace, or protect foundation openings with cofferdams in accordance with approved methods whenever necessary.
- B. Excavate the foundation pits to permit placement of the full width and length of the footings shown on the drawings with full horizontal beds. Rounded or undercut corners and edges of footings will not be permitted. All rock and other hard foundation material shall be free from all loose material, cleaned, and cut to a sound surface (clean, solid rock) that is level, stepped, or roughened. Clean all seams, and fill with concrete, mortar, or sand. When concrete is to rest on an excavated surface other than rock, take special care not to disturb the bottom of the excavation, and do not remove the final two" (2) inches of the foundation material to grade until the day before the concrete is to be placed. Maintain excavation free from standing water insofar as is practicable.
- C. When the condition of the excavation for footings is such that concrete cannot be placed without mud becoming mixed with the concrete but is otherwise satisfactory, perform special operations to remedy such conditions. Place enough sand, coarse aggregate, or a combination of such aggregates or else place a layer of roofing felt or similar material to prevent the infiltration of mud; otherwise, remove the entire mass of mud, and replace with suitable stable material.
- D. Place no concrete in the foundation until the depth of excavation and the character of the foundation material have been inspected by the A/E and approved.

### 3.3 BACKFILLING

- A. Before placing backfill, all pieces of wood and any other deleterious materials shall be removed from the surface receiving backfill.

- B Use only approved materials that will provide a dense, well-compacted backfill. Backfill material shall be free of frozen lumps, vegetation, and debris. Finely shot limestone or sandstone may be used providing no individual fragment is larger than four (4) inches in any dimension. Do not use limestone or sandstone fragments larger than four (4) inches except with the A/E's permission; when such fragments are allowed, place them as directed by the A/E. Before backfilling is started, clear the excavated pits of all form material and rubbish; when practicable, the pits shall be dewatered.
- C Place and compact backfill material in uniform horizontal layers no more than six (6) inches thick (loose measurement). Compact each layer with mechanical tampers. Do not allow successive blows of the tamper to overlap less than 1/4 of the width of the tamper head. Dampen each layer whenever necessary to ensure the maximum density obtainable, as directed by the A/E. Backfill that will be beneath or within a proposed embankment shall meet the compaction requirements for embankment required by the contract.
- D Except when otherwise noted on the drawings, complete the backfill to the elevation of the original ground, and shape the area lying outside the limits of roadway embankment to a uniform finish.
- E As a precaution against introducing unbalanced stresses in walls or columns, place and compact backfill to the same elevation on both sides of walls or piers, and then proceed to the next layer.
- F When the slopes bounding the excavated pit lie within the slope limits of 6:1 and 1/4:1, destroy the planes of the slopes by stepping or serrating to prevent wedging action during compaction.
- G Place no backfill against any concrete or masonry structure until permission has been given by the A/E.,
- H Large vibratory rollers shall not be used to compact any backfill immediately behind a structure, e.g. retaining walls. In these areas, approved mechanical tampers may be used to compact materials in successive uniform horizontal layers not exceeding six (6) inches.
- I Dispose of all excavated material not used for backfilling as the A/E directs.

END OF SECTION

## PART 1. GENERAL

- 1.1 The work called for by this section shall consist of clearing and grubbing, loosening, loading, removing, and disposing of in the specified manner, all wet and dry materials (including rock) encountered that must be removed for construction purposes; furnishing, placing, and maintaining ail sheeting, shoring, bracing, and timbering necessary for the proper protection and safety of the work; the workmen, the public, and adjacent property and improvements; the dewatering of trenches and other excavations; the preparation of satisfactory pipe beds; the backfilling and tamping of trenches, foundations, and other structures; the preparation of fills and embankments; the removal of unsuitable material from outside the normal limits of excavation and, where ordered by the A/E, their replacement with suitable materials; and all other grading or excavation work incidental to or necessary for the work. This work shall be considered incidental to the installation of all yard piping, utilities, and water lines in which no additional pay item will be allowed and shall be performed as specified below.

## PART 2. PRODUCTS

Not Used.

## PART 3. EXECUTION

### 3.1 PREPARATION OF THE SITE

,

- A. Before starting construction, remove from the work site all vegetable growth (except as hereinafter excluded and/or as directed by the A/E), debris, and/or other objectionable matter as well as any buildings and/or other structures that the drawings and/or the A/E specifically indicate are to be removed. Dispose of this refuse material offsite and in a manner acceptable to the A/E.
- B. In certain areas it may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be shown on the drawings, specifically listed in the specifications, marked on the site, or identified by the A/E. In no case damage or remove such growth without written permission from the Owner.
- C. If the area to be excavated is occupied by trees, brush, or other vegetable growth, clear such growth, grub the excavated area, and remove all large roots to a depth of not less than two (2) feet below the bottom of the proposed construction. Dispose of the removed growth offsite and in a

manner satisfactory to the A/E. Fill all holes or cavities created during this work that extend below the subgrade elevation with suitable material, and compact to the same density as the surrounding material.

- D. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the A/E. Take special precautions to protect and preserve such growth throughout all stages of the construction.
- E. Preparation of the site shall be considered an integral part of the excavation and one for which no separate payment shall be allowed.

### 3.2 UNSUITABLE MATERIALS

A. Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered, remove it and continue excavation until suitable material is encountered. The material removed shall be disposed of in the manner described below. Then refill the areas excavated for this reason with one (1) inch to two (2) inch lifts of crushed stone up to the level of the lines, grades, and/or cross sections shown on the drawings. The top six- (6) inches of this refill shall be No. 67 (DOT) crushed stone for bedding. No additional pay item will be allowed for this replacement material and work.

### 3.3 ROCKS AND BOULDERS

- A. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made therefor.
- B. Should rock be encountered in the excavation, remove it by blasting or otherwise. Where blasts are made, cover the excavation with enough excavation material and/or timber or steel matting to prevent danger to life and property. The Contractor shall secure, at his own expense, all permits required by law for blasting operations and the additional hazard insurance required. Observe all applicable local, state and federal laws and ordinances pertaining to blasting operations and coordinate with the local officials.
- C. Excavate rock over the horizontal limits of excavation and to a depth of not less than six (6) inches below the bottom of pipe up to 30 inches in diameter and not less than 12 Inches below the bottom of larger pipes If rock extends to such depth. Then backfill the space below grade with No. 67 (DOT) crushed stone or other approved material, tamp to the proper grade, and make ready for construction. For monolithic concrete sewer manholes and



for structures, excavate rock to the outside bottom of the structure or sewer. Bedding and backfilling stone will be considered incidental to installing yard piping, utilities and water lines and no pay item will be allowed. Reference other applicable sections for installation methods.

### 3.4 DISPOSAL OF MATERIALS

- A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the drawings or directed by the A/E shall be used for these purposes upon approval by the A/E. Any materials not so used shall be considered waste materials and disposed of by the Contractor as specified below.
- B. Waste materials may be deposited in spoil areas at locations approved by the A/E. Do not leave in unsightly piles but instead spread in uniform layers, neatly level, and shape to drain. Seed as specified in Section 02485, Seeding. Should areas not be available as determined by the A/E, then the excess materials shall be disposed of offsite by the contractor at his expense and at a location as determined by the contractor.
- C. Once any part of the work is completed, properly dispose of all surplus or unused materials (including waste materials) left within the construction limits of that work. Leave the surface of the work in a neat and workman like condition, as described below.
- D. The disposal of waste materials shall be considered an integral part of the excavation work and one for which no separate payment shall be allowed.

### 3.5 EXCAVATION FOR TRENCHES, MANHOLES, AND STRUCTURES

- A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of water, sewer, and other pipes and their appurtenances (including manholes, inlets, outlets, headwalls, collars, concrete saddles, and pipe protection) that are called for by the drawings. It shall include clearing and grubbing where necessary, backfilling and tamping pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth elsewhere in these specifications.
- B. The Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connections.

- C Unless the construction of lines by tunneling, jacking, or boring is called for by the drawings or specifically authorized by the A/E, make excavation for pipelines in open cut and true to the lines and grades shown on the drawings or established by the A/E on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed, but shall not be more than the distance determined by the following formula:  $\frac{4}{3}d + 15$  inches, where "d" represents the internal diameter of the pipe in inches. When approved in writing by the A/E, the banks of trenches from the ground surface down to a depth not closer than one (1) foot above the top of the pipe may be excavated to non-vertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline in accordance with the formula given above. Any cut made in excess of the formula  $\frac{4}{3}d + 15$  inches shall be at the expense of the Contractor and may be cause for the A/E to require that stronger pipe and/or a higher class of bedding be used at no cost to the Owner.
- D For rigid pipe, shape the bottom of all trenches to provide uniform bearing for the bottom of the pipe barrel and install a minimum of six (6) inches of suitable bedding material as approved by the A/E. The bedding material to be utilized can be soil material (free of rock and vegetation material) or crushed rock from a rock trenching machine if utilized during installation. Should suitable bedding material not be available then the contractor will be required to install No. 67 stone as the bedding material. For plastic sewer lines, provide a minimum of six (6) inches of No. 67 ( ) crushed stone for bedding. Bedding material will not be considered as an allowable pay item.
- E Excavate bell holes for bell and spigot pipe at proper intervals so that the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper jointing of the pipe. Do not excavate bell holes more than two (2) joints ahead of pipe laying.
- F Excavation for manholes, inlets, and other incidental structures shall not be greater in horizontal area than that required to allow a two (2) foot clearance between the outer surface of the structure and the walls of the adjacent excavation or of the sheeting used to protect it. The bottom of the excavation shall be true to the required shape and elevation shown on the drawings. No earth backfilling will be permitted under manholes, inlets, headwalls, or similar structures. Should the Contractor excavate below the elevations shown or specified, he shall, at his own expense, fill the void with either concrete or granular material approved by the A/E.
- G Do not excavate pipe trenches more than 200 feet ahead of the pipe laying, and perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the A/E deems necessary to maintain vehicular or pedestrian traffic.

- H In all cases where materials are deposited along open trenches, place them so that in the event of rain no damage will result to the work and/or to adjacent property.
- I Excavation for other structures may be performed with non-vertical banks except beneath pavements or adjoining existing improvements. Do not permit the horizontal area of the excavation to exceed that required to allow two (2) feet clearance between the outer surface of the structure and the banks of the excavation or the sheeting used to protect the embankments. The bottom of the excavation shall be true to the required shape and elevation shown on the drawings.

### 3.6 SHEETING, SHORING, AND BRACING

- A. Take special care to avoid damage wherever excavation is being done. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing, which are considered an incidental part of the excavation work.
- B. Wherever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than five (5) feet high to a stable slope, or else provide some equivalent means of protection. Effectively protect trenches less than five (5) feet deep when examination of the ground indicates hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.
- C. Comply with all OSHA standards in determining where and in what manner sheeting, shoring, and bracing are to be done. The sheeting, shoring, and bracing system shall be designed by a professional engineer licensed in KY be subject to approval by the A/E. However, such approval does not relieve the Contractor of the sole responsibility for the safety of all employees, the effectiveness of the system, and any damages or injuries resulting from the lack or inadequacy of sheeting, shoring, and bracing.
- D. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the sides of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent

structures wherever necessary, with the approval of the A/E.

- E. Do not leave sheeting, shoring, or bracing materials in place unless this is called for by the drawings, ordered by the A/E, or deemed necessary or advisable for the safety or protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.
- F. Fill and compact all holes and voids left in the work by the removal of sheeting, shoring, or bracing as specified herein.
- G. The Contractor may use a trench box, which is a pre-fabricated movable trench shield composed of steel plates welded to a heavy steel frame. The trench box shall be designed to provide protection equal to or greater than that of an appropriate shoring system.

### 3.7 THE DEWATERING OF EXCAVATION

- A. Provide and keep in operation enough suitable pumping equipment whenever necessary or whenever directed to do so by the A/E. Give special attention to excavations for those structures that, prior to proper backfilling, are subject to flotation from hydrostatic uplift.

### 3.8 BORROW EXCAVATION

- A. Whenever the backfill of excavated areas or the placement of embankments requires more material than is available from authorized excavations, or whenever the backfill material from such excavations is unsuitable, then obtain additional material from other sources. This may require the opening of borrow pits at points accessible to the work. In such cases, make suitable arrangements with the property owner and pay all incidental costs, including any royalties, for the use of the borrowed material. Before a borrow pit is opened, the quality and suitability of its material shall be approved by the A/E. All state, federal and local regulations concerning borrow pits, drainage and erosion control shall be strictly followed.
- B. Excavate borrow pits in such a way that the remaining surfaces and slopes are reasonably smooth and that adequate drainage is provided over the entire area. Construct drainage ditches wherever necessary to provide outlets for water to the nearest natural channel, thus preventing the formation of pools in the pit area. Leave the sides of borrow pit cuts at a maximum slope of 2:1 unless otherwise directed by the A/E.
- C. Properly clear and grub borrow pits, and remove all objectionable matter from the borrow pit material before placing it in the backfill.
- D. The taking of materials from borrow pits for use in the construction of

backfill, fills, or embankments shall be considered an incidental part of the work; no separate payment shall be made for this.

### 3.9 BACKFILLING

- A. Begin backfilling after the line construction is completed and then inspected and approved by the A/E. On each side of the line, from the bottom of barrel to one (1) foot above the top of the pipe, the backfill material shall consist either of fine, loose earth like sandy soil or loam or of granular material that is free from clods, vegetable matter, debris, stone, and/or other objectionable materials and that has a size of no more than two (2) inches. Place this backfill simultaneously on either side of the pipe in even layers that before compaction are no more than six (6) inches deep. Thoroughly and completely tamp each layer into place before placing additional layers.
- B. If plastic sewer pipe issued, install No. 67 crushed stone in a six (6) inch envelope on all sides of the pipe, then add the remaining backfill up to one (1) foot above the top of the pipe as described in the previous paragraphs.
- C. From one (1) foot above the pipe upward, the backfill material may contain broken stones that make up approximately 3/4 of the backfill's total volume. However, if this type of backfill is used, there must be enough spalls and earth materials to fill all voids completely. The maximum dimension of individual stones in such backfill shall not exceed six (6) inches, and the backfill material shall be placed and spread in even layers not more than 12 inches deep. At locations beneath or closely adjacent to pavement or at locations of improvements subject to damage by displacement, tamp and thoroughly compact the backfill in layers that, before compaction, are six (6) inches deep. In other areas, the backfill for the upper portion of the trenches may be placed without tamping but shall be compacted to a density equivalent to that of adjacent earth material as determined by laboratory tests. Use special care to prevent the operation of backfilling equipment from causing any damage to the pipe.
- D. If earth material for backfill is, in the opinion of the A/E, too dry to allow thorough compaction, then add enough water so that the backfill can be properly compacted. Do not place earth material that the A/E considers too wet or otherwise unsuitable.
- E. Wherever excavation has been made within easements across private property, the top one- (1) foot of backfill material shall consist of fine loose earth free from large clods, vegetable matter, debris, stone, and/or other objectionable materials.

- F. When within or adjacent to existing roadways, drives, parking areas or other vehicular traveled areas, backfill shall be with No. 67 crushed stone to the top of the trench. The trench should be compacted in no more than 6-inch lifts to the top and repaired in a timely manner as described in the following paragraphs.
- G. Upon permanent repair of the drive, roadway or parking area, remove only enough of the crushed stone depth that is required to be replaced with the permanent repair material of asphalt paving, concrete, or gravel. Refer to the County Roadway Repair Contract for county roadway repair details and requirements.
- H. Wherever trenches have been cut across or along existing pavement, temporarily pave the backfill of such trenches by placing Class A, Grade D, crushed stone as the top 12 inches of the backfill.
- I. Maintain this temporary pavement either until the permanent pavement is restored or until the Owner accepts the project. On heavily traveled roadways, cold mix or leveling course binder two (2) inches thick shall be installed and maintained until permanent pavement is installed.
- J. Conduct backfilling around manholes, inlets, outfalls, and/or structures in the same manner as specified above for pipelines except that even greater care is necessary to prevent damage to the utility structure.
- K. Wherever pipes have diameters of 15 inches or less, do not use power operated tampers to tamp that portion of the backfill around the pipe within one (1) foot above the pipe.
- L. Perform backfilling so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary, whenever directed to do so by the A/E.
- M. Backfilling and dean-up operations shall closely follow pipe laying; failure to comply with this provision will result in the A/E's requiring that the Contractor's other activities be suspended until backfilling and clean-up operations catch up with pipe laying.
- N. Compaction Requirements: Unless specified otherwise elsewhere, under buildings and two (2) times the depth of pipe beyond, and under roads and two (2) times the depth beyond the shoulder, compact to 95% maximum density in accordance with ASTM D698. In all other locations, compact to 90% maximum density.

### 3.10 MAINTENANCE

- A Seed and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Owner.
- B Maintain trenches backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the A/E. Continue such maintenance until final acceptance of the project, or until the A/E issues a written release.

### 3.11 SLOPES

- A. Neatly trim all open cut slopes, and finish to conform either with the slope lines shown on the drawings or the directions of the A/E. Leave the finished surfaces of bottom and sides in reasonably smooth and uniform planes like those normally obtainable with hand tools, though the Contractor will not be required to use hand methods if he is able to obtain the required degree of evenness with mechanical equipment. Conduct grading operations so that material is not removed or loosened beyond the required slope.

END OF SECTION

PART 1. GENERAL

- 1.1 The work called for by this section shall include, but not necessarily be limited to, finish grading and the spreading and shaping of topsoil to the finished contour elevations indicated by the drawings.
- 1.2 Refer to other sections for work related to that specified under this heading. Coordinate this work with that specified by other sections for timely execution.

PART 2. PRODUCTS

- 2.1 Topsoil: Use stripped topsoil that has been stockpiled as specified elsewhere. If the - quantity of topsoil on the job is inadequate, furnish enough additional topsoil. Topsoil furnished shall be natural, fertile, friable soil possessing characteristics of representative productive soils in the vicinity. It shall be obtained from naturally well drained areas. It shall not be excessively acid or alkaline nor contain toxic substances that may be harmful to plant growth. Topsoil shall be without admixture of subsoil and shall be cleaned and reasonably free from clay lumps, stones, stumps, roots, or similar substances two (2) inches or more in diameter, debris, or other objects that are a hindrance to planting operations. Such material shall be subject to testing.

PART 3. EXECUTION

- 3.1 Do not begin work until the earth is dry enough to be tillable.
- 3.2 Inspect subgrades to see that they generally conform to the standards called for elsewhere in these specifications, particularly with regard to the approximate depths required for the work. After work is completed, inspect it to ensure that all finish grading complies with design requirements.
- 3.3 Place finished grade stakes wherever necessary to bring the work accurately to the elevations required by the drawings.



- 3.1 Finished grade all areas outside the building line to the depths required for the work as follows:
- A. Grade uniformly with rounded surfaces at the tops and bottom of abrupt changes of planes.
  - B. Hand grade steep slopes and areas that are inaccessible for machine work.
  - C. Protect graded areas from undue erosion, and repair and regrade areas where erosion does occur. -
  - D. Refill areas where noticeable settlement has occurred.
  - E. Finished grade areas that are to receive topsoil are to receive up to four (4) inches below the finished contour elevations called for by the drawings or, when over rock, shall receive twelve (12) inches below these elevations.
  - F. Carefully rake the topsoil by hand to remove all clods, roots, sticks, stones over one (1) inch in diameter, and other foreign materials from the surface.
- 3.2 Place topsoil uniformly over disturbed areas that do not receive other work as follows:
- A. Obtain approval of the finish grading from the A/E before starting to place topsoil.
  - B. Scarify subgrade to a depth of three (3) inches.
  - C. Place the topsoil to a depth of four (4) inches when lightly rolled or, when on rock, to a depth of twelve (12) inches.
  - D. Level the topsoil so that it slopes uniformly and has no water pockets.
  - E. Carefully rake the topsoil by hand to remove all clods, roots, sticks, stones over one (1) inch in diameter, and other foreign materials from the surface.
- 3.3 Dispose of excess excavated materials and debris away from the site.

**PART 1. GENERAL**

This item consists of furnishing and placing riprap slope protection in accordance with the drawings and specifications.

**PART 2. PRODUCTS**

The riprap material shall be durable and of hard natural stone or broken concrete. It shall be sound and dense; free from cracks, seams, or other defects that would tend to cause increased deterioration because of freezing and thawing or other natural causes. Riprap material shall be reasonably well graded from the minimum size stone. At least 90% of the riprap stone shall be not less than ten (10) inches wide by twelve (12) inches long by 24 inches deep and shall be approximately rectangular in shape. Fragments or spalls shall be used to fill the voids between the larger rocks. The inclusion of appreciable quantities of dirt, sand, clay, or rock fines will not be accepted. All materials considered for use, as riprap shall be approved by the A/E.

**PART 3. EXECUTION**

- 3.1 Earth surface on which riprap is to be placed shall be trimmed, graded, and compacted so as to provide for the thickness of riprap shown on the drawings. Surfaces that are below grade shall be brought to grade by filling with well-compacted materials similar to the adjacent materials. Prior to placement of riprap, the prepared earth foundation will be inspected and no materials shall be placed thereon until approved by the A/E.
- 3.2 Place riprap to the full course thickness at one (1) operation and in such a manner as to avoid serious displacement of the underlying materials. Deliver and spread the material so that the mass of pieces in place shall be reasonably well graded, with the larger pieces uniformly distributed and the smaller pieces and spalls filling the voids between the larger pieces. The finished riprap shall be free from objectionable concentrations of large or small pieces.
- 3.3 A tolerance of plus twelve (+12) inches or minus four (-4) inches from slope lines and grades shown on the drawings will be permitted in the finished surface of the riprap, except that the extreme minus tolerance shall not be continuous over an area exceeding 200 square feet.

END OF SECTION

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PART 1. GENERAL

- 1.1 Furnish all necessary labor, material, and equipment to ensure the eradication and control of termite infestation on all levels of the building and to render a termite protection guarantee in force as specified herein.
- 1.2 The Contractor should visit the site of the work and acknowledge that he has satisfied himself as to the nature and location of the work; the general and local conditions particularly accessibility to locations where work must be accomplished, location of pest harborage areas, and other items affecting execution of the work; structural details of the buildings; limitations on time of work; availability of labor, character of equipment, supplies and facilities needed preparatory to and during execution of the work; and all other matters on which information is reasonably obtainable and which can in any way affect the work or its cost. Any failure by the Contractor to acquaint himself with all available information will not relieve him from the responsibility of estimating the difficulty and cost of properly performing the work.
- 1.3 Present certification indicating satisfactory performance in insect and pest control for a minimum period of five (5) years. The Contractor shall be bonded and insured be certified by the state, and be a member of the National Pest Control Association.
- 1.4 Provide written assurance that areas, buildings, and/or structures treated will be free from reinfestation for the period of five (5) years and that, if reinfestation occurs during the guarantee period, the Contractor will retreat any and all portions of the area, buildings and/or structures which may be reinfested within 24 hours after notification of infestation at no additional cost.
- 1.5 The guarantee and contract price shall include the cost of reinspection and the furnishing of a written report to the Owner by the Contractor's representative on the first anniversary of the effective date of the guarantee specified herein.
- 1.6 Protect at all times all personnel, materials, chemicals, supplies, property, and equipment of every description.

- 1.7 The Contractor and his representative at the site shall be thoroughly trained in pesticide first aid.

## PART 2. PRODUCTS

- 2.1 Application of all insecticides and pesticides shall be performed by licensed applicators or under direct supervision of a licensed applicator. Insecticides, including equipment shall be of types approved by the governing authorities, shall be of approved strength, and shall be applied so that excessive fumes or fogs do not adversely affect personnel in adjoining structures or buildings. All materials, equipment, and methods shall comply with the requirements of the government bodies having jurisdiction.
- 2.2 Materials and methods to accomplish the specified results are the responsibility of the Contractor within the limits set forth in this section.
- 2.3 All items of equipment proposed for use shall be free from defects and shall be kept in good working condition. Use respirators, masks, gloves, and associated items of equipment where required for safety.
- 2.4 All pesticides to be used shall be registered with EPA. Pesticide containers shall display the manufacturer's product label showing the EPA registration number and directions for its use. Apply pesticides only as directed and only against the pests listed on the label.

## PART 3. EXECUTION

- 3.1 Make no applications in occupied spaces until all occupants have vacated the premises. Apply pesticides so as to prevent toxic exposure to personnel, pets, wildlife, ornamental plants, and any other non-target components of the environment. Exercise caution to ensure that toxicants do not run off as surface flow or contaminate any ditch, culvert, drainage system, or standing body of water. Do not store or keep any pesticide or pesticide material at the site when not working. All pesticides provided by the Contractor shall be kept either in a locked vehicle or under the immediate and direct control of the Contractor. Pesticide dispersal and formulating equipment shall not be cleaned at the installation. Remove empty pesticide containers from the installation for disposal by the Contractor
- 3.2 Furnish the specified guarantee on the Contractor's standard form.
- 3.3 Apply to all grade level slabs and at a six (6) feet perimeter of building.

END OF SECTION

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**PART 1. GENERAL**

- 1.1 This work shall be performed in all disturbed areas not receiving such site improvements as buildings, roads, walks, sod, planting, etc., and shall include, but not necessarily be limited to, all seed bed preparation; the supplying and placing of soil additives, seed, and mulch wherever required by the drawings or directed by the A/E; and maintenance. All sloped areas to receive grass cover such as backwash lagoons, drainage ditches, graded site slopes shall be sodded with standard Kentucky Fescue sodding. These areas shall receive proper topsoil, and seed bedding prior to installation of sod. The sodded areas shall be rolled and stakes installed where necessary to establish full growth. The seeded and sodded areas shall be watered regularly by the contractor as to establish growth to a point acceptable by the A/E. Install erosion control matting at locations to be determined in the field by the A/E as to additionally stabilize certain identified areas.
- 1.2 Unless otherwise approved in writing by the A/E, seeding operations shall be limited to the following planting periods:
- A. Spring - March 1 through May 30
  - B. Fall - August 15 through October 31
- 1.3 Refer to other sections for items affecting seeding. Coordinate this work with that specified by other sections for timely execution.

**PART 2. PRODUCTS**

- 2.1 GRASS SEED: Kentucky 31 Fescue (*Festuca elatior*) and/or annual rye meeting the requirements of the State Department of Agriculture and furnished in new bags or bags that are sound and not mended; no "below standard" seed will be accepted. Oats shall also be seeded as to establish a vegetative ground cover to prevent erosion.
- 2.2 FERTILIZER: commercially manufactured; Grade 10-10-10; furnished in standard containers that are clearly marked with the name, weight, and guaranteed analysis of the contents and that ensure proper protection in transportation and handling; and in compliance with all local, state, and federal fertilizer laws.

- 2.3 AGRICULTURAL LIMESTONE: containing a minimum of 85% calcium carbonate and magnesium carbonate combined, 85% of which passes a No. 10 mesh sieve.
- 2.4 MULCH: stalks of rye, oats, wheat, or other approved grain crops properly cured prior to baling, air dried, and reasonably free of noxious weeds and weed seeds or other material detrimental to plant growth.

### PART 3. EXECUTION

- 3.1 Perform all seeding and related work as a continuous operation. Sow seed as soon as the seedbed has been prepared, and perform subsequent work in a continuous manner.
- 3.2 Before beginning seeding operations in any area, complete the placing of topsoil and final grading, and have the work approved by the A/E.
- 3.3 Scarify, disk, harrow, rake, or otherwise work each area to be seeded until the soil has been loosened and pulverized to a depth of not less than two (2) inches. Perform this work only when the soil is in a tillable and workable condition.
- 3.4 Apply fertilizer and agricultural limestone uniformly over the seedbed, and lightly harrow, rake, or otherwise incorporate them into the soil for a depth of approximately one (1) inch at the following rates:

Fertilizer: 15 pounds per 1,000 square feet

Agricultural Limestone: 40 pounds per 1,000 square feet

- 3.5 Sow seed uniformly with a rotary seeder, wheelbarrow seeder, hydraulic equipment or by other satisfactory means.
- 3.6 The seeding rate shall be five (5) pounds per 1,000 square feet for Kentucky 31 Fescue (*Festuca elatior*).
- 3.7 When seeding during March 1 through April 1 and October 1 through November 20, add an additional three (3) pounds per 1,000 square feet of annual rye grass.
- 3.8 Perform no seeding during windy weather or when the ground surface is frozen, wet, or otherwise untillable.
- 3.9 Spread mulch material evenly over the seeded areas immediately following the seeding operation.

Mulch Rate: Two (2) bales (100 pound minimum) per 1,000 square feet

- 3.10 The mulch rate may be varied by the A/E, depending on the texture and condition of the mulch material and the characteristics of the area seeded. Cover all portions of the seeded areas with a uniform layer of mulch so that approximately 25% of the ground is visible.

3.11 No equipment, material storage, construction traffic, etc., will be permitted on newly seeded ground.

3.12 Dispose of all surplus materials as directed by the Owner.

#### PART 4. INSPECTIONS

The A/E shall inspect the seeding within 60 days after planting and determine if it is acceptable.

#### PART 5. GUARANTEE

5.1 Secure an acceptable growth of grass in all areas designated for seeding.

5.2 An area is considered acceptable if it is represented by a minimum of 100 seedlings per square foot of the permanent species of grass representative of the seed mixture. If an acceptable growth is not obtained on the first planting, reseeding and remulching will be required.

5.3 If the planting is less than 90% successful, rework the ground, refertilize, reseed, and remulch those areas not established. Any areas not establishing grass shall be reseeded as directed by the A/E. Areas that are subject to erosion runoff where grass seed cannot be established shall be sodded.

END OF SECTION

## CONCRETE REPAIR

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. **General.** Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to this section.

#### 1.2 DESCRIPTION OF WORK

- A. **General.** The Contractor shall furnish all labor, tools, equipment, and materials necessary to repair the spalled, deteriorated, and delaminated areas of existing concrete, concrete joints and necessary cleaning or replacement of reinforcing steel in accordance with the plans and as specified herein.
- B. **Safety Requirements**
1. The Contractor is responsible for providing all shoring required to insure the support, stability and integrity of the overall structure and its individual components.
  2. All work is to be done in accordance with all applicable safety standards.
- C. **Scope of Work**
1. Repair of existing exterior concrete hatches located on roofs of reservoirs.
- D. **Equipment**
1. Use maximum 30 pound chipping hammers to remove concrete. The use of jack hammers or hydraulic hoe-ram type hammers will not be permitted at any time on this project.
  2. Hydrodemolition is an acceptable alternative method of removing delaminated, deteriorated concrete on the walls and beams only.
  3. Use self-contained blasting equipment or equal to mechanically abrade all concrete surfaces to be coated with flexible epoxy coating system.

#### 1.3 QUALITY ASSURANCE

- A. **Codes and Standards.** Comply with provisions of the following codes, specifications, standards and guides except where more stringent requirements are shown or specified:



1. American Concrete Institute (ACI) 546R-96 "Concrete Repair Guide."
  2. ICRI Technical Guideline No. 03730, "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcing Steel Corrosion."
  3. ICRI Technical Guideline No. 03733, "Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces."
  4. ICRI Technical Guideline No. 03731, "Guide for Selecting Application Methods for the Repair of Concrete Surfaces."
  5. ACI 318 "Building Code Requirements for Structural Concrete."
  6. ACI 301 "Standard Specification for Structural Concrete."
  7. ACI 315 "Details and Detailing of Concrete Reinforcements."
  8. Concrete Reinforcing Steel Institute (CRSI) "Reinforcing Bar Detailing."
- B. **Experience.** Contractor and equipment manufacturer shall have a minimum of 5 years' experience in the successful completion of concrete restoration and repair projects.
1. Installation of flexible epoxy coating system shall be performed by an applicator having satisfactory experience in the application of these or similar materials or with on-site consultation by a qualified field service representative of product manufacturer.
- C. **Examination.** Authorized representatives of the Owner shall have access and the right to examine the work under this contract at all times.
- D. **Testing.** Materials and installed work may require testing and retesting at any time during progress of work.
1. Retesting of rejected materials for installed work, shall be done at Contractor's Expense.
- E. **Job Standard.** Prior to installation of flexible epoxy coating system, the contractor shall install, with the owner's approval, a mutually agreed upon test sample to show final color and appearance of the system. This test area shall serve as a job standard for the final installation.

#### 1.4 SUBMITTALS

- A. **General.** Submit the following in accordance with conditions of contract and Division 1 specification sections.
1. Product data for proprietary materials and items, including reinforcement and forming accessories, bonding compounds, repair mortars, admixtures, patching compounds, waterstops, joint systems, curing compounds, sealers, flexible epoxy coating systems, and others as requested by Engineer.
  2. Installation details for flexible epoxy coating system.
  3. Concrete mix design.
- B. **Materials specified indicate a standard** of quality required on this project.

Contractor may submit alternate materials to the Owner for approval. Alternate materials may not be used without approval from the Owner.

- C. **Colored Samples.** Prepare and provide samples of colored repair materials in place where patching materials are placed on wall surfaces exposed to view that do not receive an additional surface coating. Adjust manufacturer recommended coloring agents to simulate existing surface color. Owner, contractor, and manufacturer shall review and mutually agree upon color, grade, and final texture of flexible epoxy coating system before starting installation. The acceptance of a sample will constitute the job standard by which installation will proceed.

## 1.5 JOB CONDITIONS

Not Used.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. **Manufacturer's recommendations shall be followed** in the delivery, storage and handling of all materials.
- B. **Store materials only in areas approved** by the Owner.

## 1.7 SPECIAL WARRANTY

Not used.

# PART 2 - PRODUCTS

## 2.1 MATERIALS

### A. General

- 1. The types of repair materials shall be as noted below for each specific repair condition.

### B. Reinforcement

- 1. Welded wire fabric shall conform to American Society for Testing and Materials (ASTM) A 185.
- 2. Deformed reinforcing bars shall conform to ASTM A 615, Grade 60.
- 3. All reinforcement shall be epoxy-coated per ASTM A 775.
  - a. Provide epoxy touch-up paint of a different color to coat nicks, cuts, and ends of bars in field.
  - b. Use plastic or epoxy-coated bar supports and tie wire to prevent electrical coupling between bars.

### C. Bonding Agent/Corrosion Protection

- 1. Corr-Bond bonding agent. Euclid Chemical Company.

2. EMACO P-24 bonding agent. Master Builders Technologies.
3. Sika Armatec 110 bonding agent. Sika Corporation.

**D. Vertical Surface Patch Repair Mortar**

1. Verticoat Supreme, microsilica and latex modified one component nonsag repair mortar. Euclid Chemical Company.
2. EMACO S88-CI repairs mortar. Master Builders Technologies.
3. SikaTop 123 Plus, a two-component polymer-modified mortar for repairs from 1/8" to 1-1/2" with greater depths using 1-1/2" lifts. Sika Corporation.

**E. Horizontal Surface Patch Repair Mortar**

1. Eucocrete repair mortar. Euclid Chemical Company.
2. EMACO T430 rapid strength repair mortar. Master Builders Technologies.
3. SikaTop 122 Plus, polymer modified two component kit for repairs greater than 1/2 inch, but less than 7 inches. Sika Corporation.

**F. Curing**

1. Curing materials and methods shall be in strict accordance with manufacturer's recommendations for the specific materials used.
2. Wet cure horizontal repairs for a minimum of 7 days.

**G. Flexible Epoxy Coating System** components listed below are by Tnemec Company, Inc./Ohio Coating Consultants (1-800-890-7580). Equal system may be used with engineer approval.

1. Primer: Series 201 Epoxoprime, multipurpose penetrating polyamine cured epoxy primer.
2. Flexible Membrane: Series 206 Sub-Flex EP flexible epoxy.
3. Topcoat: Series 291 Endura-Shield, chemical resistant urethane finish.

**H. Crack and Joint Sealant**

1. Euclid Chemical Company.
  - a. Primer. Eucolastic/NEO Seal Primer.
  - b. Sealant. Eucloastic.
2. Sika Corporation.
  - a. Primer. Sikaprime 429.
  - b. Sealant. Sikaflex 2c SL.
3. Sonneborn.
  - a. Primer. Primer 733.
  - b. Sealant. NP1 or NP2.

**PART 3 - EXECUTION**

### 3.1 CONCRETE PREPARATION

- A. **In areas to be patched or poured** to a new surface, all loose, delaminated and disintegrated concrete, dirt, debris, impregnations, foreign materials, etc., shall be removed and the areas thoroughly cleaned by approved methods.
  - 1. The Contractor shall determine the location and extent of the repair areas. The surfaces shall be sounded by tapping with a rod, hammer, or chain drag method in the presence of the Owner. All unsound areas shall be marked by the contractor and removed as approved by the Owner.
  - 2. Saw-cut edges of repairs a minimum of 1 inch deep. Take special precautions not to cut or nick existing reinforcement. Provide square or rectangular areas of repair. Sound concrete is to be removed within the saw-cut areas as necessary.
  - 3. Removal shall be done by hand-chipping, water-blasting, or other method that will accomplish the work in a manner that will not damage or shatter the concrete that is to remain. Fine particles shall be removed by air and water operated at not less than 50 psi. Care shall be used in working around the existing reinforcing steel so as to not contact the steel directly with a pneumatic hammer or hand tool, which may cut the steel or shatter the concrete around and beyond the repair area. See Reinforcement Preparation below.
- B. **Areas of existing concrete to be coated with Flexible Epoxy Coating System** shall be mechanically abraded by means of self-contained blasting equipment or equal to remove all laitance and surface contaminants and provide a minimum profile similar to 40-60 grit sandpaper (Reference ASTM D 4259, ICRI CSP 3-5). After mechanically abrading, verify that all surfaces are clean, dry, and free of any contaminants which could adversely affect the adhesion of the flooring system.
- C. **Off-site disposal of all materials removed** shall be the responsibility of the Contractor.

### 3.2 REINFORCEMENT PREPARATION

- A. **Rusted reinforcing bars** and mesh exposed by the removal of spalled, delaminated, or unsound concrete shall have sufficient sound concrete removed to a minimum of 3/4 inch around the bar.
- B. **The total surface of exposed** reinforcing steel shall be cleaned of all rust and scale. Measure the average diameter of each piece of exposed reinforcing at its thinnest point. Where the area of steel remaining is less than 85 percent of its original nominal area, splice in new reinforcing. The size and length of the new reinforcing will be determined by the Owner, and will be based on the area of reinforcing remaining and on other factors.

### 3.3 SUBSTRATE ACCEPTANCE

- A. **After all deteriorated concrete has been removed** down to a sound substrate, all surfaces shall be inspected by the Owner or the authorized representative of

the Owner for soundness. Subsequent areas identified as not being sound shall be removed. Approval by the Owner is required prior to the application of any repair materials.

- B. **Any repair material which is placed** by the Contractor without acceptance of the substrate by the Owner, or the authorized representative of the Owner, will be removed and replaced by the Contractor at no additional cost to the Owner.

### 3.4 TEMPERATURE

- A. **Hot and cold weather placement of concrete** shall be in accordance with ACI 305 and ACI 306.
- B. **Consult the manufacturer for mixing**, placing, and curing procedures of repair mortars when the ambient temperature is below 50 degrees Fahrenheit (° F.) or above 85° F.
- C. **Any day during which the curing temperature** falls below 45° F. shall not be counted as a curing day. If, at any time during the curing period, the curing temperature falls below 35° F. the work will be rejected and removed and replaced.
- D. **For flexible epoxy coating system**, surface and surrounding air temperatures must exceed 55° F but must be less than 90° F with materials at not less than 55° F during application.

### 3.5 GENERAL PATCHING PRECAUTIONS

- A. **A technical representative of each material supplier** shall review and approve the procedures prior to the use of their materials.
- B. **Presaturate all surfaces to be patched** as specified by the manufacturer's instructions.
- C. **For patches thicker than 1-1/2 inches** add 3/8-inch washed pea gravel.
- D. **Do not install patches** within 90 feet of any area where concrete is being removed.
- E. **Protect all patches from premature drying** and excessively hot or cold weather for the necessary period for the proper setting of the patch. Cure the patch per manufacturer's recommendations or for seven days, maintaining a temperature of 50° F. or more.
- F. **Protect patches against rain and inclement weather** with tarpaulins or similar waterproof protection until the patch has set.

### 3.6 VERTICAL/HORIZONTAL SURFACE PATCH REPAIR

- A. **Follow concrete and reinforcement preparation** per 3.1 and 3.2 above.

- B. **Apply bonding agent to substrate** and exposed reinforcement. Alternatively, substrate may be coated with a scrub coat of patching material immediately prior to application of patching material.
- C. **Mixing and placing of repair mortars** shall be in accordance with manufacturer's instructions.
- D. **Finish surfaces to match existing.**
- E. **Properly cure and seal all repairs** per manufacturer's recommendations.

### 3.7 CRACK REPAIR

- A. **Identify** concrete crack locations.
- B. **Prepare surface** per manufacturer's recommendations.
- C. **Rout or saw-cut crack** to 1/4-inch by 1/4-inch minimum configuration.
- D. **Blow clean joint** with oil-free compressed air and mechanically clean crack surface per manufacturer's recommendations.
- E. **Mix and place repair materials** in accordance with the manufacturer's instructions.
- F. **Properly cure all repair materials** per manufacturer's recommendations.

3.8 **ACCEPTANCE.** The Owner or the authorized representative of the Owner shall review all areas and items repaired. Any work found to be defective or unsatisfactory shall be removed and replaced at no additional cost to the Owner.

3.9 **CLEANUP.** Remove all waste materials, rubbish, and debris and dispose of them at the owner's discretion.

4.0 **PROTECTION.** Protect the completed flexible epoxy coating system from water, airborne particles or other surface contaminants until cured for 24 hours. Protect from traffic, physical abuse, immersion and chemical exposure until the complete system has thoroughly cured for the minimum equivalent of 24 hours at 75°F. For different temperatures, consult the manufacturer's representative about curing times.

END OF SECTION

**CAST-IN-PLACE CONCRETE****PART 1 – GENERAL**

- 1.1 **RELATED DOCUMENTS.** Drawings and general provisions of Contract, including General and Supplementary Conditions, Division 1, and all related specification sections, apply to this section.
- 1.2 **DESCRIPTION OF WORK.** Furnish and install cast-in-place concrete in accordance with the drawings and specifications.
  - A. **This section specifies** cast-in-place concrete, including formwork, reinforcing, mix design, accessories, placement procedures, joints, embedments, finishes, curing, supports for equipment and piping, and grout toppings for tanks.
  - B. **Other specification sections** may reference this section for other cast-in-place concrete items.
- 1.3 **QUALITY ASSURANCE**
  - A. **Standards.** Comply with the provisions of the following standards:
    - 1. ACI – American Concrete Institute.
    - 2. ASTM – American Society for Testing and Materials.
    - 3. CRSI – Concrete Reinforcing Steel Institute.
    - 4. AASHTO – American Association of State Highway and Transportation Officials.
  - B. **Concrete Testing Service.** Engage an acceptable laboratory to perform material evaluation tests and to design concrete mixes.
  - C. **Testing.** Materials and installed work may require testing and retesting at any time during progress of work. Retesting of rejected materials or installed work shall be done at Contractor's expense.
  - D. **Concrete Conference.** Prior to submittal of design mixes, conduct conference at project site to comply with the following:
    - 1. Review detailed requirements for preparing concrete design mixes.
    - 2. Determine procedures for satisfactory concrete operations.
    - 3. Review requirements for submittals, status of coordinating work, and availability of materials.

4. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications.
5. Request that representatives of each entity directly concerned with cast-in-place concrete attend conference, including, but not limited to, the following:
  - a. Contractor's superintendent.
  - b. Laboratory responsible for concrete mix design.
  - c. Laboratory responsible for field quality control.
  - d. Ready-Mix concrete supplier.
  - e. Concrete subcontractor.
  - f. Primary admixture manufacturers.
  - g. Engineer/Architect or Owner's Representative.
6. Concrete conference may be waived by the Engineer/Architect or Owner's Representative.

1.4 **SUBMITTALS.** Submit all submittals in accordance with the Division 1 Submittal Requirements and the requirements within this specification section.

**A. Submittal Package No. 1 – Shop Drawings and Product Data**

1. Product data for materials and items, such as cement, reinforcement, embedded forming accessories, admixtures, patching compounds, waterstops, joint systems, and curing compounds.
2. Reinforcement shop drawings for fabrication, bending, and placement of concrete reinforcement. Comply with ACI SP-66 (88), "ACI Detailing Manual," showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangement of concrete reinforcement. Include special reinforcement required for openings through concrete structures, and dowel reinforcement for masonry.
3. Concrete mix designs for each class of concrete to be used on the project including specifics regarding admixtures proposed for each mix design. Include concrete test reports to substantiate trial batch mixes or previous performance of the same mix design.
4. Materials Certificates.
  - a. Submit with the concrete mix design.
  - b. Signed by manufacturer certifying that each material item complies with or exceeds specified requirements.
  - c. Provide certification from admixture manufacturers that chloride content complies with specification requirements.
  - d. Construction joint locations which clearly show where construction joints are intended to be placed in walls, slabs, columns, beams, at stairwells, etc.
  - e. Box Outs. Proposed locations.



5. Testing Laboratories. Submit the names of the testing laboratories proposed for use to perform the material evaluation tests and also to perform the field quality control testing. An ACI certified technician shall perform all concrete testing.

**B. Submittal Package No. 2 – Batch Tickets**

1. Submit batch tickets for each load of concrete used on the job that indicate the design mix, the project name, the date, the time of batching, and the truck number.

**C. Submittal Package No. 3 – Test Reports**

1. The concrete testing laboratory shall submit two copies of all concrete test reports directly.

**1.5 JOB CONDITIONS**

- A. **Coordination.** Coordinate installation of joint materials, embedded items, vapor retarders, etc., with placement of forms and reinforcing steel to prevent delays, errors, or omissions.
- B. **Reference Material.** Provide a copy of ACI SP-15, Field Reference Manual, in the field office at all times during concrete construction.
- C. **Climatic Conditions.** Perform placement and curing of concrete under various weather conditions in accordance with ACI 301, "Specifications for Structural Concrete for Buildings," ACI 305, "Hot Weather Concreting," and ACI 306, "Cold Weather Concreting," except as modified herein.

- 1.6 **DELIVERY, STORAGE, AND HANDLING.** Comply with ACI 304, "Recommended Practice for Measuring, Mixing, and Placing Concrete."

- 1.7 **SPECIAL WARRANTY** (Not used)

**PART 2 – PRODUCTS**

**2.1 MATERIALS**

**A. Forms**

1. Exposed finish concrete forms shall be plywood, metal, metal framed plywood faced, or other acceptable panel type materials, to provide continuous, straight, smooth, exposed surfaces. Furnish in largest practicable sizes to minimize number of joints and to conform to joint system shown.

2. Unexposed finish concrete forms shall be plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.
  3. Cylindrical column and support forms shall be metal, fiberglass reinforced plastic, or paper or fiber tubes.
    - a. When used, provide paper or fiber tubes of laminated plies with water resistant adhesive and wax impregnated exterior for weather and moisture protection.
    - b. Provide sufficient wall thickness to resist wet concrete loads without deformation.
- B. **Form coatings.** Commercial formulation form coating compounds with a maximum volatile organic compound (VOC) of 350 milligrams per liter (mg/l) that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- C. **Form ties.** Factory-fabricated, adjustable length, removable or snap-off metal form ties, designed to prevent form deflection and to prevent spalling concrete upon removal.
1. Provide units that will leave no metal closer than 1 inch to exposed surface.
  2. Provide ties that, when removed, will leave holes not larger than 1 1/2 inch diameter in concrete surface.
- D. **Reinforcing Materials**
1. Reinforcing Bars. ASTM A 615, A 616, including Supplemental Requirement S1, or A 617; Grade 60, deformed.
  2. Epoxy Coated Reinforcing Bars. ASTM A 775.
  3. Welded Wire Fabric. ASTM A 185, welded steel wire fabric, provided in flat sheets.
  4. Supports for Reinforcement. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use steel bar supports or precast concrete bar supports complying with CRSI specifications.
    - a. For slabs on grade, use steel bar supports with sand plates or horizontal runners or precast concrete bar supports where base material will not support chair legs.

- b. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are plastic protected (CRSI, Class 1) or stainless steel (CRSI, Class 2).

**E. Concrete Materials**

1. Portland Cement. ASTM C 150, Type I or Type II in areas where alkali-aggregate reaction is a problem. Use one brand of cement throughout project.
2. Fly Ash. ASTM C 618, Type C or Type F including supplementary optional physical requirements, except loss on ignition shall not exceed 3 percent.
3. Normal Weight Aggregates. ASTM C 33 and as herein specified.
  - a. For exposed concrete, provide aggregates from a single source.
  - b. For exterior exposed surfaces, do not use fine or coarse aggregates containing deleterious substances which might cause spalling.
  - c. Fine Aggregate. Fine aggregate shall consist of natural sand or manufactured sand.
  - d. Coarse Aggregate. Coarse aggregate shall consist of crushed rock, gravel, or crushed gravel.
    - 1) Grading. The coarse aggregate shall conform to requirements for Size 57, unless otherwise approved.
    - 2) Deleterious substances shall not exceed the percentages for Class 4S.
4. Water. Potable.
5. Admixtures. Provide admixtures that contain a maximum of 0.05 percent chloride ions by weight of cement when tested in accordance with AASHTO T260. Certificate from admixture manufacturer will be required prior to mix design approval.
  - a. Air-Entraining Admixture.

- 1) ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
  - 2) Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
    - a) Darex II or Daravair, W.R. Grace & Co.
    - b) MB-VR or Micro-Air, Master Builders, Inc.
    - c) Sika AER, Sika Corp.
    - d) AEA-92 or Air Mix 200, Euclid Chemical Co.
- b. Water-Reducing Admixture.
- 1) ASTM C 494, Type A.
  - 2) Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
    - a) Eucon WR-75 or WR-89, Euclid Chemical Co.
    - b) WRDA with Hycol, or Daracem-55, W.R. Grace & Co.
    - c) Pozzolith 220-N, Pozzolith 322-N, or Polyheed, Master Builders, Inc.
    - d) Plastokrete 161, Sika Corp.
- c. High-Range Water-Reducing (HRWR) Admixture (Super Plasticizer).
- 1) ASTM C 494, Type F or Type G.
  - 2) Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
    - a) Eucon 37, Euclid Chemical Co.
    - b) Daracem 19, Daracem ML330, or Daracem ML500, W.R. Grace & Co.
    - c) Rheobuild, Master Builders, Inc.
    - d) Sikament 300, Sika Corp.
- d. Noncorrosive, Nonchloride Accelerating Admixture.

- 1) ASTM C 494, Type C or E.
  - 2) Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
    - a) Accelguard 80, Euclid Chemical Co.
    - b) Polarset, W.R. Grace & Co.
    - c) Pozzutec 20, Master Builders, Inc.
- e. Water-Reducing, Retarding Admixture.
- 1) ASTM C 494, Type D.
  - 2) Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
    - a) Eucon Retarder 75, Euclid Chemical Co.
    - b) Daratard-17, W.R. Grace & Co.
    - c) Pozzolith R, Master Builders, Inc.
    - d) Plastiment, Sika Corporation.
- f. Crystalline Waterproofing Admixture. Subject to compliance with requirements, products that may be incorporated in the work include the following:
- 1) Penetron ADMIX.
  - 2) Aquafin-IC.
  - 3) Kryton KIM.
  - 4) Xypex ADMX C-Series.
  - 5) BASF Rheomac 300D.

## 2.2 ACCESSORIES

- A. **Reglets.** Where resilient or elastomeric sheet flashing or bituminous membranes are terminated in reglets, provide reglets of not less than 0.0217-inch-thick (26-gauge) galvanized sheet steel. Fill reglet or cover face opening to prevent intrusion of concrete or debris.
- B. **Polyvinyl (PVC) Chloride Waterstops.** Corps of Engineers CRD-C 572.
1. Waterstops for construction joints shall be serrated type without center bulb and at least 3/8 inch thick and 6 inches wide.

2. Waterstop for expansion joints shall be serrated type with center bulb and at least 3/8 inch thick and 9 inches wide.
3. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
  - a. Greenstreak Plastic Products Co.
  - b. DuraJoint.
  - c. BoMetals, Inc.

**C. Bitumen Waterstops**

1. Provide a single component self-sealing plastic adhesive type waterstop which is nonoxidizing, nonevaporating, nonexpanding, nonshrinking, and resistant to water, chemicals, and saturated hydrogen sulfide.
2. Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:
  - a. Synko-Flex, Synko-Flex Products.
  - b. Seal-Tite, DuraJoint.

**D. Sand Cushion.** Clean, manufactured or natural sand conforming to ASTM C 33 or C 144.

**E. Vapor Retarder.** ASTM E 1745 Class A Compliant with a permeance of 0.01 before and after mandatory conditioning as required by (ASTM E 1745 Section 7.1 and Sub-paragraphs 7.1.1 – 7.1.5).

1. Provide vapor retarder cover over prepared base material where indicated below slabs on grade.
2. Subject to compliance with these specifications, the vapor retarder may be one of the following:
  - a. Stego Wrap 15 mil by Stego Industries, LLC
  - b. Vapor Flex by Layfield
  - c. Moistop Ultra 15 by Fortifiber Industries

**F. Chemical Hardener.** Colorless aqueous solution containing a blend of magnesium fluosilicate and zinc fluosilicate combined with a wetting agent, containing not less than 2 pounds of fluosilicates per gallon.

1. Use hardener on existing concrete where noted.
2. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:

- a. Surfhard, Euclid Chemical Co.
- b. Lapidolith, Sonneborn-Rexnord.
- c. Burk-O-Lith, The Burke Co.
- d. Fluohard, L&M Construction Chemical, Inc.

**G. Sealer/Dustproofers**

- 1. Floor hardener compound for new concrete shall be an acrylic containing not less than 14 percent solids.
- 2. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
  - a. Super Diamond Clear VOX, Euclid Chemical Company.
  - b. Dress and Seal WB30, L&M Construction Chemicals, Inc.

**H. Absorptive Cover.** Burlap cloth made from jute or kenaf, weighing approximately 9 ounces per square yard, complying with AASHTO M 182, Class 2.

**I. Moisture-Retaining Cover.** One of the following complying with ASTM C 171.

- 1. Waterproof paper.
- 2. Polyethylene film.
- 3. Polyethylene coated burlap.

**J. Curing Compound.** Clear styrene acrylate type, 30 percent solids content minimum.

- 1. Submit test data from an independent testing laboratory indicating a maximum moisture loss of 0.55 kilograms (kg) per square meter when applied at a coverage rate of 200 square feet per gallon.
- 2. Verify compatibility of curing compound with finishes to be used.
- 3. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
  - a. Super Diamond Clear VOX, Euclid Chemical Company.
  - b. Dress and Seal WB30, L&M Construction Chemicals, Inc.

**K. Evaporation-Control Compound**

1. Monomolecular film-forming compound applied to exposed concrete slab surfaces for temporary protection from rapid moisture loss.
2. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
  - a. Aquafilm, Conspec Marketing and Mfg. Co.
  - b. Eucobar, Euclid Chemical Co.
  - c. E-Con, L&M Construction Chemicals, Inc.
  - d. Confilm, Master Builders, Inc.

**L. Bonding Compound**

1. Polyvinyl acetate or acrylic base.
2. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
  - a. Polyvinyl Acetate (Interior Only).
    - 1) Superior Concrete Bonder, Dayton Superior Corp.
    - 2) Euco Weld, Euclid Chemical Co.
    - 3) Weld-Crete, Larsen Products Corp.
    - 4) Everweld, L&M Construction Chemicals, Inc.
  - b. Acrylic or Styrene Butadiene.
    - 1) SBR Latex, Euclid Chemical Co.
    - 2) Daraweld C, W.R. Grace & Co.
    - 3) Acryl-Set, Master Builders, Inc.
    - 4) Stonlock LB2, Stonhard, Inc.

**M. Epoxy Adhesive**

1. ASTM C 881, two-component material suitable for use on dry or damp surfaces.
2. Subject to compliance with requirements, products that may be incorporated in the work include, but are not limited to, the following:
  - a. Euco Epoxy System #452 or #620, Euclid Chemical Co.
  - b. Epabond, L&M Construction Chemicals, Inc.
  - c. Concresive 1001, Master Builders, Inc.
  - d. Sikadur 32 Hi-Mod, Sika Corp.



N. **Expansion Joint and Isolation Joint Material.** Use one of the following unless noted otherwise.

1. Self-expanding cork conforming to ASTM D 1752, Type III.
2. Cellular fiber-asphalt conforming to ASTM D 1751.
3. Neoprene/SBR polymer conforming to ASTM D 1056-67.

## 2.3 MIXES

### A. General

1. Prepare design mixes for each type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301.
2. If trial batch method used, retain an acceptable independent testing facility for preparing and reporting proposed mix designs.
3. The testing facility shall not be the same as used for field quality control testing.
4. Submit mix designs of each proposed mix for each class of concrete at least 15 days prior to start of work.
5. Do not begin concrete production until proposed mix designs have been reviewed.
6. Limit use of fly ash not to exceed 25 percent of cement content by weight.
  - a. In areas where alkali aggregate reaction is a problem, do not add less than 20 percent fly ash by weight.
  - b. When used, fly ash shall replace cement at a 1:1 ratio for Class C fly ash and a 1.25:1 ratio for Class F fly ash (Class F fly ash to cement).
  - c. Adjust weights of concrete materials to provide the correct yield.

B. **Design Mixes.** Provide normal weight concrete with the following properties, unless otherwise indicated. Tolerance for air content shall be  $\pm 1$  percent.

1. Class A. 4,000 pounds per square inch (psi), 28-day compressive strength.
  - a. Water/Cementitious Product (w/c) ratio, 0.45 maximum; minimum cementitious material, 611 pounds per cubic yard (cy).
  - b. 6 percent air.
2. Class B. 3,000 psi, 28-day compressive strength.

- a. w/c ratio, 0.50 maximum; minimum cementitious material, 541 pounds per cy.
    - b. 6 percent air.
  - 3. Class C. 2,000 psi, 28-day compressive strength.
    - a. w/c ratio, 0.6 maximum; minimum cementitious material, 376 pounds per cy.
    - b. 6 percent air.
  - 4. Class D.
    - a. w/c ratio, 0.45 maximum; minimum cementitious material, 846 pounds per cy.
    - b. Fine aggregate to cement ratio shall not exceed 3.0 by weight.
    - c. 6 percent air.
  - 5. Class S. 4,500 psi, 28-day compressive strength.
    - a. w/c ratio, 0.42 maximum; minimum cementitious material, 564 pounds per cy.
    - b. 6 percent air.
  - 6. Class W. In accordance with Class S, except:
    - a. Contains crystalline waterproofing admixture in accordance with paragraph 2.1.E.5.f.
    - b. Dose in accordance with admixture manufacturer's recommendations.
- C. **Slump Limits.** Proportion and design mixes to result in concrete slump at point of placement as follows:
- 1. Ramps and sloping surfaces. Less than 3 inches.
  - 2. Reinforced foundation systems. 2 to 4 inches.
  - 3. Concrete containing HRWR admixture (Superplasticizer). Less than 8 inches after addition of HRWR to site verified 2-inch to 3-inch slump concrete without HRWR.
  - 4. Other concrete. Less than 4 inches for slabs and less than 5 inches for walls, curbs, bases, and other miscellaneous concrete.
- D. **Chloride Content.** The maximum water-soluble chloride ion content, expressed as a percent by weight of cement contributed by all ingredients of the concrete mix shall not exceed 0.10 percent.

- E. **Controlled Density Fill or Controlled Low-Strength Material.** The fine aggregates shall be fine enough to stay in suspension in the mixture to the extent required for proper flow. Provide with the following properties, unless otherwise indicated:
1. 100 psi, 28-day compressive strength.
    - a. Cement, 100 pounds.
    - b. Fly Ash, 250 pounds.
    - c. Fine Aggregate, Saturated Surface Dry, 2,800 pounds.
    - d. Water, 500 pounds maximum.
  2. It is necessary for bleed water to appear on the surface immediately after the fill is struck off.
    - a. A delay in bleeding indicates there are too many fines in the mixture, so reduce the fly ash quantity in increments of 50 pounds until mixture is bleeding freely.
    - b. Add approximately 60 pounds of sand to replace each 50-pound increment of fly ash to maintain the original yield.
- F. **Dry Pack Mortar.** Mix dry pack, consisting of one part portland cement to 2 1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
- G. **Cement Mortar.** A mixture of sand, cement, and water in the same proportions used for the concrete being placed, but omit all coarse aggregate.
- H. **Adjustment to Concrete and Mixes.** Request mix design adjustments when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, as approved. Submit laboratory test data for revised mix design and strength results for acceptance before using in work.
- I. **Admixtures.** Use of Admixtures.
1. Use water-reducing admixture for placement and workability in all classes of concrete unless noted otherwise.
  2. A noncorrosive nonchloride accelerating admixture may be used in concrete slabs placed at ambient temperatures below 50 degrees Fahrenheit (° F.) when approved.
  3. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content as indicated in the design mix.
- J. **Concrete Mixing.** Ready Mix Concrete. Comply with requirements of ASTM C 94 and as specified.

1. When air temperature is between 85° F. and 90° F., mixing and delivery time shall not exceed 75 minutes.
2. When air temperature is above 90° F., mixing and delivery time shall not exceed 60 minutes unless approved otherwise.

## **PART 3 – EXECUTION**

### **3.1 EXAMINATION**

- A. **Tolerances.** Unless otherwise specified, tolerances shall be in accordance with ACI 117 and ACI 301.
- B. **Inspection**
  1. Before placing concrete, inspect and complete formwork installation, reinforcing steel, and items to be embedded or cast-in.
  2. Notify other trades to permit installation of their work; cooperate with other trades in setting such work.
  3. Verify that all wood, dirt, foreign objects, and all other debris have been removed from inside the formwork.
  4. Verify that reinforcing steel is spaced to provide the proper coverage against forms and against earth for slabs on grade.
  5. When requested, provide documentation of inspection prior to placing concrete.
- C. **Site and Weather Conditions.** Do not place concrete when site conditions exist such as standing water, extreme heat or cold, etc., unless the proper precautions have been taken to properly place and protect concrete as recommended by ACI and as acceptable. Do not place concrete on frozen ground.

### **3.2 PREPARATION**

- A. **Forms**
  1. General. Design, erect, support, brace, and maintain formwork to support vertical and lateral, static and dynamic loads that might be applied until concrete structure can support such loads. Maintain formwork construction tolerances complying with ACI 347.
  2. Forms.
    - a. Construct forms to sizes, shapes, lines, position, elevation, and dimensions shown and to obtain accurate alignment, location, grades, level, and plumb work in finished structures.
    - b. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work.
    - c. Use selected materials to obtain required finishes.

- d. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.
3. Fabrication of Forms.
- a. Fabricate forms for easy removal without hammering or prying against concrete surfaces.
  - b. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces.
  - c. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only.
  - d. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
4. Openings.
- a. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete.
  - b. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar.
  - c. Locate temporary openings in forms at inconspicuous locations.
5. Exposed Corners and Edges. Chamfer exposed corners and edges using wood, metal, PVC, or rubber chamfer strips to produce uniform smooth lines and tight edge joints.
6. Provisions for Other Trades.
- a. Provide openings in concrete formwork to accommodate work of other trades.
  - b. Determine size and location of openings, recesses, and chases from trades providing such items.
  - c. Accurately place and securely support items built into forms.
7. Cleaning and Tightening.
- a. Thoroughly clean forms and adjacent surfaces to receive concrete.
  - b. Remove wood, sawdust, dirt, or other debris just before concrete is placed.
  - c. Retighten forms and bracing before concrete placement as required to prevent mortar leaks and maintain proper alignment.

8. Form Coatings. Coat contact surfaces of forms with an approved, nonresidual, low VOC, form coating compound before reinforcement is placed.
  - a. Do not allow excess form coating material to accumulate in forms or to come into contact with in-place concrete surfaces against which fresh concrete will be placed. Apply in compliance with manufacturer's instructions.
  - b. Coat steel forms with a nonstaining, rust preventative material. Rust stained steel formwork is not acceptable.
  - c. Form coatings for use in water treatment plants shall be nontoxic after 30 days from the date the forms are removed.

#### **B. Reuse of Forms**

1. Clean and repair surfaces of all forms to be reused in work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable for exposed surfaces.
2. Apply form coating compound as specified for new formwork.
3. Successive Reuse.
  - a. When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close joints.
  - b. Align and secure joint to avoid offsets.
  - c. Do not use "patched" forms for exposed concrete surfaces except as approved.

### **3.3 INSTALLATION**

#### **A. Vapor Retarder Installation**

1. Install vapor retarder where shown per ASTM E/643-10.
2. Following leveling and tamping of granular base for slabs on grade, place vapor retarder sheeting with longest dimension parallel with direction of pour.
3. Lap joints 6 inches and seal vapor barrier joints with manufacturer's recommended mastic and/or pressure sensitive tape.

#### **B. Placing Reinforcement**

1. Comply with CRSI's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports and as herein specified.

2. Clean reinforcement of loose rust and mill scale, earth, ice, and other materials that reduce or destroy bond with concrete.
3. Installation.
  - a. Accurately position, support, and secure reinforcement against displacement.
  - b. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as approved.
  - c. Place reinforcement to obtain at least minimum coverages for concrete protection as noted in ACI 301.
  - d. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations.
  - e. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
  - f. Install welded wire fabric in lengths as long as practicable.
  - g. Lap adjoining pieces at least one full mesh plus 2 inches or 8 inches and lace splices with wire.
  - h. Offset laps of adjoining widths to prevent continuous laps in either direction.
  - i. Avoid cutting or puncturing vapor retarder barrier during reinforcement placement and concreting operations.

### **C. Joints**

1. Construction Joints. Locate and install construction joints as indicated or, if not indicated, locate so as not to impair strength and appearance of the structure.
  - a. Provide keyways 1-1/2 inches deep in construction joints in walls and slabs and between walls and footings. Accepted bulkheads designed for this purpose may be used for slabs.
  - b. Place construction joints perpendicular to main reinforcement. Continue reinforcement across construction joints except as otherwise indicated.
  - c. The maximum length of wall pours shall not exceed 40 feet, and slab pours shall not exceed 40 feet in length or width.
  - d. Bond fresh concrete to hardened new concrete as follows:
    - 1) For horizontal joints, place new concrete on a 1-inch layer of cement mortar evenly spread over the previously

- placed concrete. Thoroughly clean and remove laitance of previously placed concrete.
  - 2) For vertical joints, thoroughly clean the surface of the hardened concrete and remove all laitance prior to placing new concrete.
- e. If noted, prior to placement of new concrete against old existing concrete, apply bonding agent to surface of old concrete, if accessible, immediately before placement of new concrete.
  - f. Make provisions to support and protect exposed waterstops during progress of work. Field-fabricate joints in waterstops in accordance with manufacturer's printed instructions. Provide continuous waterstops in construction joints as follows:
    - 1) Liquid-bearing walls and slabs.
    - 2) Walls or slabs subject to groundwater and/or in contact with ground.
    - 3) Elsewhere as indicated.
2. Isolation Joints in Slabs-on-Ground. Construct isolation joints as indicated in slabs-on-ground at points of contact between slabs-on-ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as shown. Fill joints where noted with sealant specified in Division 7 sections of these specifications.
3. Contraction (Control) Joints in Slabs-on-Ground.
- a. Construct contraction joints in slabs-on-ground to form panels of patterns as shown.
  - b. Use saw cuts 1/8 inch wide by 1/4 slab depth or insert pre-molded plastic, hardboard, or fiberboard strip into fresh concrete until top surface of strip is flush with slab surface unless otherwise indicated.
  - c. Tool slab edges round on each side of insert.
  - d. After concrete has cured, remove inserts and clean groove of loose debris.
    - 1) Saw-cut as soon as possible after slab finishing without dislodging aggregate.
    - 2) If joint pattern not shown, provide joints not exceeding 15 feet in either direction and located to conform to bay



- spacing wherever possible (at column centerlines, half bays, third bays).
  - 3) Provide joint, filler, and sealant materials where shown.
4. Control Joints in Retaining Wall.
- a. Provide control joints at 32 feet on center maximum unless otherwise shown.
  - b. Provide 1-1/2 inch deep by 1/3 wall thickness vertical keyway.
  - c. Horizontal reinforcing shall not pass through joint.
  - d. Joints need not be provided in retaining wall footings.
5. Expansion Joints. Construct expansion joints where shown. If not shown, provide expansion joints at interval not to exceed the following:
- a. Retaining Walls. 96 feet (not required in footings).
6. Waterstop. Provide waterstops in all joints shown and listed in this specification.
- a. Provide PVC waterstops in all joints unless noted otherwise.
  - b. Properly support and wire all waterstops to reinforcing to remain straight and true. Heat-splice all joints per manufacturer's recommendations.
  - c. Provide bitumen waterstop in joint between new and existing concrete.
  - d. Provide factory made waterstop fabrications for all changes in direction, intersections, and transitions leaving only butt-joint splicing for the field.
  - e. Provide hog rings spaced at 12 inches on center along the length of the waterstop to provide attachment to rebar without puncturing waterstop for proper positioning.

#### **D. Installation of Embedded Items**

- 1. Set and build into the work, anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by other prime Contractors and suppliers of items to be attached thereto.
- 2. Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, relieving angles, and other conditions.
- 3. Set edge forms, bulkheads, and intermediate screed strips for slabs to obtain required elevations and contours in finished surfaces. Provide and secure units to support screed strips using strike-off templates or compacting type screeds.

**E. Concrete Placement**

1. Location. Provide concrete as specified in the table below unless otherwise indicated.

Location	Design Mix
All reinforced concrete and nonreinforced fillets	4,500 psi Class S
Nonreinforced concrete not designated as Class A, C, or D	3,000 psi Class B
Nonreinforced so designated	2,000 psi Class C
Grout fill or topping as designated	Class D
Reinforced concrete so designated	Class W

2. General. Comply with ACI 304, "Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete," and as specified herein.
  - a. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness, or to be resistant to the penetration of a vibrator.
  - b. If a section cannot be placed continuously, provide construction joints as specified herein.
  - c. Deposit concrete to avoid segregation at its final location.
3. Placing Concrete in Forms. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints.
  - a. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
  - b. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  - c. Use equipment and procedures for consolidation of concrete in accordance with ACI 309.

- d. Do not use vibrators to transport concrete inside forms.
  - e. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than visible effectiveness of machine.
  - f. Place vibrators to rapidly penetrate placed layer and at least 6 inches into preceding layer.
  - g. Do not insert vibrators into lower layers of concrete that have begun to set.
  - h. At each insertion, limit duration of vibration to time necessary to consolidate concrete around reinforcement and other embedded items without causing segregation of mix.
4. Placing Concrete Slabs. Deposit and consolidate concrete slabs in a continuous operation, within limits of construction joints, until the placing of a panel or section is completed.
- a. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - b. When epoxy-coated reinforced steel is used, vibrators shall have nonmetallic heads.
  - c. Bring slab surfaces to correct level with straightedge and strike off. Use highway straightedge, bull floats, darbies, or other means to obtain a smooth surface which is free of humps or hollows and that conforms to the required flatness and levelness.
  - d. Do not disturb slab surfaces prior to beginning finishing operations.
  - e. Maintain reinforcing in proper position during concrete placement.
5. Protection for Slab Construction. Ensure that the concrete floor moisture levels do not exceed flooring manufacturer's recommended moisture level.
- a. Be responsible for controlling the moisture content of interior concrete slabs. Achieve each respective flooring manufacturer's specifications prior to installation. Conduct calcium chloride absorption rate tests in sufficient number to properly substantiate compliance. No additional construction time or extra costs will be approved for failure to satisfy this requirement.
  - b. Follow construction practices that will help control the moisture in the slabs (i.e., a low water-to-cement ratio, careful installation of the vapor barrier, properly compacted subgrade free of standing water or mud, surface protection for completed slabs, proper temporary heating and ventilation).
  - c. Once the building is enclosed, control the humidity level in spaces (dew point temperature should be 20 degrees below the surface temperature of the slab). If necessary, include the use of desiccant dehumidifiers.

6. Cold Weather Placing. Comply with provisions of ACI 306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - a. When air temperature has fallen to or is expected to fall below 40° F., uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature between 50° F. and 80° F. at point of placement.
  - b. Do not use frozen materials or materials containing ice or snow.
  - c. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - d. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.
7. Hot Weather Placing. When hot weather conditions exist that would seriously impair quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
  - a. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90° F. Mixing water may be chilled, or chopped ice may be used to control temperature provided water equivalent of ice is included in the total amount of mixing water. Use of liquid nitrogen to cool concrete is allowed.
  - b. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
  - c. Fog spray forms, reinforcing steel, and subgrade just before concrete is placed.
  - d. Use water reducing retarding admixture when required by high temperatures or other adverse placing conditions, when acceptable.
  - e. Use evaporation control compound in accordance with manufacturer's recommendations or fogging.
8. Adjusting Concrete Slump at Job Site.
  - a. Slump Greater than Specified. Do not use concrete with slump greater than specified.
  - b. Slump Less than Specified. If on arrival at the job site, the slump of the concrete is less than specified, the following remedies may be used.

- 1) Add water only if the maximum specified w/c ratio is not exceeded.
- 2) Accompany additional water by a quantity of cement sufficient to maintain the specified w/c ratio.
- 3) Add an approved water reducing admixture.

**F. Controlled Density Fill or Controlled Low-Strength Material Placement**

1. General. Unless noted otherwise, place controlled density fill in overexcavated areas under slabs, in utility trenches within roadways, and as directed.
2. Mixing Equipment. Provide sufficient mixing capacity to permit fill to be placed without interruption.
3. Placing Fill.
  - a. Discharge flowable fill from the mixer by any reasonable means into the space to be filled.
  - b. Bring up the fill material uniformly to the fill line shown or as directed.
  - c. Placing of any material over low strength fill may commence as soon as the surface water is gone or as directed.

**G. Finish of Formed Surfaces.** Classify inside face of covered basins, clear wells and reservoirs, filters below the media line, open tanks and flumes below water or flow lines, and the outside of structures below finish grade lines as not exposed to view.

1. Finish. Finish formed concrete surfaces in accordance with the schedule below.

Location	Type of Finish
Concrete surfaces not exposed to view or surfaces to be covered with a coating material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, or other similar system	Smooth form finish
Concrete exposed to view including surfaces which will be painted	Smooth rubbed finish or grout-cleaned finish

2. Smooth Form Finish. This is an as-cast concrete surface obtained with selected form facing material, arranged in an orderly and symmetrical

manner with a minimum of seams. Repair and patch defective areas with fins and other projections completely removed and smoothed.

3. Smooth Rubbed Finish.
  - a. Provide smooth-rubbed finish not later than 1 day after form removal.
  - b. Moisten concrete surfaces and rub with carborundum brick or other abrasive until a uniform color and texture is produced.
  - c. Do not apply cement grout other than that created by the rubbing process.
  
4. Grout-Cleaned Finish.
  - a. Mix one part portland cement and 1-1/2 parts fine sand with sufficient water to produce a grout with the consistency of thick paint.
  - b. Substitute white portland cement for a part of the gray portland cement in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch.
  - c. Wet the surface of the concrete sufficiently to prevent absorption of water from the grout and apply the grout uniformly with brushes or a spray gun.
  - d. Immediately after applying the grout, scrub the surface with a cork float or stone to coat the surface and fill all air bubbles and holes.
  - e. While the grout is still plastic, remove all excess grout by working the surface with a rubber float, burlap, or other means.
  - f. After the surface whitens from drying, rub with clean burlap.
  - g. Keep the finish damp for at least 36 hours after final rubbing.
  
5. Related Unformed Surfaces. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

#### **H. Slab Finishes**

1. Finish. Finish slab surfaces in accordance with the schedule below unless shown otherwise.

<b>Location</b>	<b>Type of Finish</b>
Slabs to receive grout topping	Rough finish
Slabs to receive concrete topping or	Scratch finish

mortar setting beds for tile, Portland cement terrazzo, and other bonded applied cementitious finish flooring material	
Slabs to be covered with membrane or elastic waterproofing, membrane or elastic roofing, or sand-bed terrazzo	Float finish
Slabs of tanks, flumes, channels, wet wells, etc., which are submerged including grout toppings	Trowel finish after float finishing
Slabs to be exposed to view or covered with resilient flooring, carpet, ceramic or quarry tile, paint or other thin film finish coating system	Trowel finish after float finishing
Slabs to be covered with ceramic quarry tile installed with thin set mortar	Float finish followed by trowel and fine broom finish
Exterior concrete platforms, steps, ramps	Float finish followed by nonslip broom finish

2. Floor Levelness, General. Floor levelness requirements below do not apply to sloped slabs or unshored slabs on metal deck.

3. Scratch Finish.

- a. After placing slabs, plane surface to tolerances for floor flatness (Ff) of 20 and floor levelness (Fl) of 17.
- b. Slope surfaces uniformly to drains where required.
- c. After leveling, roughen surface before final set with stiff brushes, brooms, or rakes.

4. Float Finish.

- a. After screeding, consolidating, and leveling concrete slabs, do not work surface until ready for floating.
- b. Begin floating, using float blades or float shoes only, when surface water has disappeared, and/or when concrete has stiffened sufficiently to permit operation of power driven floats.
- c. Consolidate surface with power driven floats or by hand floating if area is small or inaccessible to power units.
- d. Check and level surface plane to tolerances of Ff 25 - Fl 20.

- e. Cut down high spots and fill low spots.
  - f. Uniformly slope surfaces to drains.
  - g. Immediately after leveling, refloat surface to a uniform, smooth, granular texture.
5. Trowel Finish.
- a. After floating, begin first trowel finish operation using a power driven trowel.
  - b. Begin final troweling when surface produces a ringing sound as trowel is moved over surface.
  - c. Consolidate concrete surface by final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with surface leveled to tolerances of Ff 50 - Fl 35.
  - d. Grind smooth surface defects that would telegraph through applied floor covering system.
6. Trowel and Fine Broom Finish. Apply trowel finish as specified, then immediately follow with slightly scarifying surface by fine brooming.
7. Nonslip Broom Finish. Immediately after float finishing, slightly roughen concrete surface by brooming with stiff fiber bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer/Architect before application.
8. Rough Finish. The bottom of concrete tanks which are to receive grout topping shall receive a rough finish for maximum adhesion. The surface to receive the grout topping shall be intentionally roughened to a minimum amplitude of 1/4 inch.
9. Chemical Hardener. Apply chemical hardener to existing interior concrete floors where indicated.
- a. Clean floors and allow to dry before applying hardener.
  - b. Apply proprietary chemical hardeners, in accordance with manufacturer's printed instructions.
  - c. After final coat of chemical hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.
10. Sealer/Dustproofer Finish.
- a. Coat all exposed surfaces and floors within buildings which will be subject to pedestrian or vehicular traffic under normal operation.
  - b. Accomplish this by applying a liquid sealer/dustproofer in three applications in accordance with the manufacturer's directions.



- c. Apply the sealer/dustproofer as late as possible and just prior to completion of construction.

**I. Placing Grout Toppings.** Grout toppings shall be Class D concrete mix design unless noted otherwise.

1. Prior to placement of the structurally bonded topping, remove all laitance, debris, and loose and foreign material from the base slab. Use water-blasting, sandblasting, or other acceptable methods.
2. Thoroughly wet the base slab before placing the grout topping. Remove all standing water from the surface prior to placing neat cement grout.
3. Brush in neat cement grout as a bonding agent immediately before application of grout topping. Do not allow neat cement grout to set prior to placing grout topping.
4. Where recommended by manufacturer, use the tank mechanism to screed the grout on the tank floor as it is placed. Screed in accordance with the manufacturer's instructions.
5. Trowel finish topping as specified above.
6. Moisture cure grout toppings as specified herein.

**J. Miscellaneous Concrete Items**

1. Filling In Holes and Openings.
  - a. Fill in holes and openings left in concrete structures for passage of work by other trades, unless otherwise shown or directed, after work of other trades is in place.
  - b. Mix, place, and cure concrete as herein specified, to blend with in-place construction.
  - c. Provide other miscellaneous concrete filling shown or required to complete work.
2. Equipment Bases and Foundations. Provide machine and equipment bases and foundations as shown. Set anchor rods for machines and equipment complying with diagrams or templates of manufacturer furnishing machines and equipment.

### 3.4 CONCRETE SURFACE REPAIRS

**A. Patching Defective Areas.** Repair and patch defective areas and plug form tie holes with cement mortar immediately after removal of forms, when acceptable.

1. Cut out honeycomb, rock pockets, and voids over 1/4 inch in any dimension down to solid concrete but in no case to a depth of less than 1 inch.
  - a. Make edges of cuts perpendicular to the concrete surface.
  - b. Thoroughly clean, dampen with water, and brush coat the area to be patched with specified bonding compound.

- c. Place patching mortar before bonding compound has dried.
- 2. For exposed-to-view surfaces, blend white portland cement and standard portland cement so that, when dry, patching mortar will match color surrounding.
  - a. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with patching.
  - b. Compact mortar in place and strike-off slightly higher than surrounding surface.
  - c. After shrinkage has occurred, grind surface until flush.
- B. **Repair of Formed Surfaces.** Remove and replace concrete having defective surfaces if defects cannot be repaired satisfactorily. Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, fins and other projections on surface, and stains and other discolorations that cannot be removed by cleaning.
- C. **Repair of Unformed Surfaces.** Repair or replace supported slabs that fail to meet the specified finish requirements.
  - 1. Correct levelness and flatness, and low and high areas as herein specified.
  - 2. For slabs on grade, remove slab between control joints and replace with concrete slab meeting floor finish and tolerances.
  - 3. For all other unformed surfaces, repair as follows:
    - a. Repair surface defects that affect the durability of the concrete. These include crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through nonreinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
    - b. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days.
    - c. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out low areas and replacing with patching compound.
    - d. Finish repaired areas to blend into adjacent concrete.
    - e. Underlayment compounds may be used when acceptable.
    - f. Repair defective areas, except random cracks and single holes not exceeding 1 inch in diameter, by cutting out and replacing with fresh concrete.

- 1) Remove defective areas to sound concrete with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around.
- 2) Dampen concrete surfaces in contact with patching concrete and apply bonding compound.
- 3) Mix patching concrete of same materials to provide concrete of same type or class as original concrete.
- 4) Place, compact, and finish to blend with adjacent finished concrete.
- 5) Cure in same manner as adjacent concrete.

D. **Miscellaneous Repairs.** Repair isolated random cracks and single holes not over 1 inch in diameter by dry pack method.

1. Groove top of cracks and cut out holes to sound concrete and clean of dust, dirt, and loose particles.
2. Dampen cleaned concrete surfaces and apply bonding compound.
3. Place dry pack mortar before bonding compound has dried.
4. Compact dry pack mixture in place and finish to match adjacent concrete.
5. Keep patched area continuously moist for not less than 72 hours.

E. **Approval.** Perform structural repairs with prior approval for method and procedure, using specified epoxy adhesive and mortar.

F. **Alternative Repair Methods.** Repair methods not specified above may be used, subject to acceptance.

### 3.5 QUALITY CONTROL TESTING DURING CONSTRUCTION

#### A. General

1. Employ an approved testing laboratory to perform tests and submit test reports.
2. ACI Grade 1 certified technician employed by the testing laboratory shall be present during the placing of all concrete.
3. The concrete testing laboratory shall submit two copies of all test reports directly to the Engineer/Architect.

B. **Sampling Fresh Concrete.** Sample concrete in accordance with ASTM C 172, except modified for slump to comply with ASTM C 94.

1. Slump. Perform slump tests at the point of truck discharge prior to adding plasticizers in accordance with ASTM C 143.
  - a. For each class of concrete, perform one test for each compressive strength test and additional tests when concrete consistency seems to have changed.
  - b. If the slump is adjusted at the job site, the concrete testing agency shall be responsible for reporting the following.

- 1) Method used to adjust slump.
  - 2) Quantity of each material added.
  - 3) Resulting slump.
2. Air Content. Perform daily for each class of concrete placed in accordance with ASTM C 173 volumetric method for lightweight concrete; ASTM C 231 pressure method for normal weight concrete; one test for each compressive strength test, one test for the first load of each type of air entrained concrete delivered, and one test for each truck when air content is adjusted until consistent results are obtained.
3. Concrete Temperature. Test hourly when air temperature is 40° F. and below, when 80° F. and above, and each time a set of compressive test specimens is made.
4. Compressive Test Specimen. Perform in accordance with ASTM C 31 and as follows:
  - a. Prepare one set of four standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field cured test specimens are required. Contractor may also prepare field cured test specimens to be used for early form removal.
  - b. Prepare one set of cylinders for each 100 cy of concrete or fraction thereof, of each concrete class placed in any one day.
  - c. Perform compressive strength tests in accordance with ASTM C 39. Test one specimen at 7 days, and two specimens at 28 days, and hold one specimen in reserve for later testing if required.
  - d. When frequency of testing will provide fewer than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.
  - e. When total quantity of a given class of concrete is less than 50 cy, Engineer/Architect may waive strength test if adequate evidence of satisfactory strength is provided.
  - f. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
  - g. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength, and no individual strength test result falls below specified compressive strength by more than 500 psi.

- C. **Compressive Strength Test Reporting.** Report test results in writing to Engineer/Architect, Ready-Mix producer, and Contractor within 24 hours after tests. Reports of compressive strength tests shall contain the project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.
- D. **Flatness and Levelness.** Conduct random tests for flatness and levelness in accordance with ASTM E 1155 within 24 hours after final finish and as directed. Pay the cost for testing and any retesting after the defects are corrected.
- E. **Floor Slope.** Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having required slope within 24 hours after final finish and as directed.
- F. **Nondestructive Testing.** Impact hammer, ultrasonic pulse velocity, or other nondestructive testing device may be permitted if approved, but shall not be used as the sole basis for acceptance or rejection.
- G. **Additional Tests.** The testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure.
  - 1. These tests shall be as directed.
  - 2. Testing service shall conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.
  - 3. Be responsible for all costs associated with such tests.

### 3.6 DEMONSTRATION

- A. **General.** Prior to final acceptance of concrete work, demonstrate to representatives of the Owner and the Engineer/Architect that there are no mechanical defects or damaged areas and that concrete exposed to view is acceptable as to function and appearance.
  - 1. **Walls and Other Formed Surfaces.** Representatives of the Owner, Contractor, and Engineer/Architect shall review concrete work to verify that tie holes and air voids have been patched, seams have been ground smooth, all surface defects have been repaired, and all rubbed or rubbed and painted surfaces are acceptable in appearance.
  - 2. **Floors.**
    - a. Representatives of the Owner, Contractor, and Engineer/Architect shall review concrete work to verify that all surface defects have been repaired, all stains removed, residue from floor sealer/dustproof or chemical hardener has been removed, and that the required finish is acceptable.

- b. Where requested, flood selected areas of floor to a depth satisfactory to demonstrate that the area or areas drain properly to the floor drains and sumps and that there are no areas ponding water outside acceptable tolerances.
  - c. Furnish water for testing and convey it to the areas being examined.
- 3. Liquid-Bearing Structures. Demonstrate that all structures designed to hold water or other liquids are watertight in accordance with ACI 350 and Section 01 89 19, "Leakage Test and Disinfection."
- B. **Repair or Replacement of Defective Work.** Correct concrete work which is unacceptable in accordance with paragraph 3.4 of this section. Replace concrete which cannot be repaired satisfactorily in an acceptable manner at no additional cost to the Owner.

### 3.7 CONCRETE CURING AND PROTECTION

- A. **General.** Protect freshly placed concrete from premature drying and excessively cold or hot temperatures. In hot, dry, and windy weather, protect concrete from rapid moisture loss before and during finishing operations with an evaporation control compound applied in accordance with manufacturer's instructions.
- B. **Curing Duration**
  - 1. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing.
  - 2. Keep continuously moist for not less than 7 days.
  - 3. Maintain concrete temperatures as recommended in ACI 301 throughout the curing period.
- C. **Curing Methods.** Perform curing of concrete by curing compound, by moist curing, by moisture-retaining-cover curing, and by combinations thereof in accordance with the schedule below unless noted otherwise.
  - 1. If unspecified, all methods specified below are acceptable.
  - 2. Prior to use of curing compound on any surface, verify compatibility between curing compound and finish surface treatment.

Location	Curing Method
Floors and other unformed concrete surfaces	Any specified curing method
Formed concrete surfaces	Moist curing prior to form removal, followed by any of the methods specified below
Slabs to receive grout topping	Moisture cure
All other concrete	Any specified curing method

3. Moisture Curing. Provide moisture curing by following methods:
  - a. Keep concrete surface continuously wet by with a continuous water fog spray.
  - b. Cover concrete surface with specified absorptive cover, thoroughly saturate cover with water, and keep continuously wet.
  - c. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4-inch lap over adjacent absorptive covers.
  
4. Moisture-Retaining-Cover Curing. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
  
5. Curing Compound. Provide curing compound as follows:
  - a. Apply specified curing compound to concrete as soon as final finishing operations are complete (within 2 hours and after surface water sheen has disappeared).
  - b. For formed surfaces, apply curing compound immediately after form removal.
  - c. Apply uniformly in continuous operation by power spray or roller in accordance with manufacturer's directions. Apply in two coats, spread in perpendicular directions.
  - d. Recoat areas subjected to heavy rainfall within 3 hours after initial application.
  - e. Maintain continuity of coating and repair damage during curing period.
  - f. Use curing compounds that will not affect finish materials applied directly to concrete.
  - g. Do not use curing compounds on surfaces which are to be covered with coating material applied directly to concrete, chemical hardener, waterproofing, dampproofing, membrane roofing, flooring (such as ceramic or quarry tile, glue down carpet that is not compatible with curing compound), painting, and other coatings and finish materials, unless otherwise approved.

3.8 **SHORES AND SUPPORTS.** Comply with ACI 347 for shoring and reshoring in multistory construction, and as herein specified.

- A. **Extend shoring from ground to roof** for structures four stories or less, unless otherwise permitted.
- B. **Extend shoring at least three floors** under floor or roof being placed for structures over four stories.

1. Shore floor directly under floor or roof being placed, so that loads from construction above will transfer directly to these shores.
  2. Space shoring in stories below this level in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members where no reinforcing steel is provided.
  3. Extend shores beyond minimums to ensure proper distribution of loads throughout structure.
- C. **Remove shores and reshore** in a planned sequence to avoid damage to partially cured concrete or to supporting floors. Locate and provide adequate reshoring to support work without excessive stress or deflection.
- D. **Keep reshores in place** a minimum of 15 days after placing upper tier, and longer if required, until concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

### 3.9 REMOVAL OF FORMS

- A. **Formwork which is not supporting** the weight of concrete, such as sides of beams, walls, columns, and similar parts of the work may be removed after cumulatively curing at not less than 50° F. for 24 hours, provided concrete is sufficiently hard not to be damaged by form removal operations, and provided curing and protection operations are maintained.
- B. **Formwork supporting weight** of concrete, such as beam soffits, joists, slabs, and other structure elements, may not be removed in less than 14 days and concrete has attained at least 75 percent of the design 28-day minimum compressive strength. Determine potential compressive strength of in-place concrete by testing field cured specimens representative of concrete location or members.
- C. **Form facing material may be removed** 3 days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

### 3.10 PROTECTION OF FORMED AND UNFORMED CONCRETE SURFACES.

Protect concrete from damage or discoloration during the construction period caused by subsequent work performed by all other trades, including, but not limited to, concrete forming, re-steel placement, equipment installation, plumbing work, electrical work, construction loading to the point of overstressing concrete, and all other actions which might adversely affect the strength or appearance of the concrete. Repair chipped or damaged concrete and remove rust, stains, efflorescence, and surface deposits by acceptable methods.

END OF SECTION



PART 1. GENERAL

- 1.1 Manholes shall be precast or monolithic concrete with concentric cones unless otherwise approved by the A/E.
- 1.2 Refer to other sections for items affecting manholes. Coordinate this work with that specified by other sections for timely execution.
- 1.3 Shop drawings are required for castings, plastic gaskets, and precast manholes specified in this section.

PART 2. PRODUCTS

- 2.1 CONCRETE MASONRY: reinforced or plain, meeting the applicable requirements of Section 03301, Concrete Work.
- 2.2 CLAY BRICK (FOR CASTING ADJUSTMENT): Clay brick shall be medium hard or better quality Grade SM sewer brick conforming to the requirements of ASTM C32. Brick shall be solid and not cored or frogged.
- 2.3 MORTAR: composed of one (1) part Portland cement and two (2) parts sand (volumetric measure) thoroughly mixed in a tight box, with water added gradually and mixed continually until mortar has attained the proper consistency for use in brick masonry; prepared only in such quantities as needed for immediate use; mortar mixed for more than 30 minutes, retempered, or previously set will not be allowed.
- 2.4 GRAY IRON CASTINGS: cast iron conforming to the requirements of Class 30, ASTM A48; made accurately to the required dimensions; sound, smooth, clean, and free from blisters and other defects; not plugged or otherwise treated to remedy defects; machined so that covers rest securely in the frames with no rocking and are in contact with frame flanges for the entire perimeter of the contact surfaces; thoroughly cleaned subsequent to machining and, before rusting begins, painted with a bituminous coating so as to present a smooth finish; tough and tenacious when cold, but not tacky and with no tendency to scale; and with the actual weight in pounds stenciled or printed by the manufacturer on each casting in white paint.

- 2.5 PLASTIC GASKET FOR PRECAST MANHOLES: Preformed plastic gasket shall meet or exceed all requirements of FS SS-S-00210, "Sealing Compound, Preformed Plastic for Pipe Joints," Type I, rope form. The sealing compound shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes, or obnoxious odors. The compound shall not depend on oxidizing, evaporating, or chemical action for its adhesive or cohesive strength. It shall be supplied in extruded rope form of suitable cross section and in such sizes as to seal the joint space when the pipes are laid. Use two (2) complete ropes at each joint. The sealing compound shall be protected by a suitable removable two (2) piece wrapper, which shall be designed so that half may be removed longitudinally without disturbing the other half in order to facilitate application of the sealing compound. The flexible plastic gasket shall also meet the requirements of the following table:

Composition	Test Method	Minimum	Maximum
Bitumen (Petroleum Plastic Content)	ASTMD4	50	70
Ash Inert Mineral Matter	AASHO T111	30	50
Volatile Matter	ASTM D6	—	2.0
Property	Test Method	Minimum	Maximum
Specific Gravity at 77 degrees F	ASTM D71	1.20	1.30
Ductility at 77 degrees F (cm)	ASTM D113	5,0	---
Softening Point	ASTM D36	320° F	---
Penetration at 77 degrees F (150 gms) 5 sec.	ASTM D217	50	120

- 2.6 LADDER BARS: an aluminum alloy weighing 2.2 pounds or 1/2 inch steel reinforced rod encapsulated in polypropylene plastic.
- 2.7 PRECAST MANHOLE COMPONENTS: meeting the requirements of the standard drawings and ASTM C478. The manhole sidewall shall be of a length such that a minimum of one course and a maximum of four (4) courses of brick shall be placed on top of the unit to bring the casting to grade. Minimum wall thickness shall be five (5) inches.
- 2.8 MATERIAL TESTING: All precast reinforced concrete manhole risers and tops specified herein shall be tested and inspected by a commercial testing laboratory approved by the A/E prior to delivery to the site, and all materials that fail to conform to these specifications shall be rejected. After delivery to the site, any materials that have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site. Supply certified copies in duplicate of the inspection and acceptance reports of the testing laboratory to the A/E before using the materials. The commercial testing laboratory shall be engaged and paid for by the Contractor. Submit a certificate

from the manufacturer of the castings indicating that they meet all applicable requirements of these specifications.

### PART 3. EXECUTION

- 3.1 Dewater sufficiently to maintain the ground water level at or below the bottom of the manhole foundation prior to and during placement of the foundation.
- 3.2 Obtain an adequate foundation for all manhole structures by removing and replacing unsuitable material with well graded granular material, by tightening with coarse rock, or by such other means as provided for foundation preparation of the connected sewers or as directed by the A/E. Wherever water is encountered at the site, place all cast-in-place bases or monolithic structures on a one-piece waterproof membrane to prevent any movement of water into the fresh concrete.
- 3.3 When the foundation subgrade has been prepared and is approved by the A/E, carefully construct the concrete foundation for monolithic manholes to the line and grade required by the drawings. Construct the manholes after the concrete foundation has been allowed to set for a period of not less than 24 hours.
- 3.4 For precast manholes, carefully block the base section above the prepared surface so that it is fully and uniformly supported in true alignment; make sure that all entering pipe can be inserted at proper grade. Then place the concrete foundation and invert under and upon this base section as shown in the standard drawings. A base section with monolithic foundation (bottom) may be used when approved by the A/E.
- 3.5 Thoroughly wet and then completely fill all lift holes and all joints between precast elements with mortar. Smooth and paint them both inside and outside to ensure watertightness.
- 3.6 Construct monolithic concrete manholes and bases of 4,000 psi concrete in accordance with the provisions of this section and applicable provisions of Section 03303, Concrete for Utility Lines. The ladder bars shall be cast in place
- 3.7 Carefully set the cast iron frame for the cover at the required elevation, and properly bond it to the masonry with cement grout and/or anchor bolts. Whenever manholes are constructed in paved areas, tilt the top surface of the frame and cover so as to conform to the exact slope, crown, and grade of the existing adjacent pavement.
- 3.8 Manhole inverts shall be constructed of concrete or Portland cement mortared masonry fill and may, at the Contractor's option, be covered with cement mortar to the approximate cross section of the sewers connected to them. Make any necessary changes in cross sections gradually from side to side of the manhole; make changes in direction of flow of the sewers to a true curve of as large a radius as is permitted by the size of the manhole. Construct brick inverts with the brick laid on edge and longitudinally with the invert channel. Inside face joints shall be not more than 1/4 inch thick.

- 3.9 All rigid unreinforced pipe entering or leaving the manhole shall be provided with flexible joints within twelve 12 inches of the manhole structure, or encase the full joint in concrete. Place such pipe on firmly compacted bedding, particularly in the area of the manhole excavation, which is normally deeper than excavation for sewer trenches. Take special care to see that the openings through which pipes enter the structures are completely and firmly rammed full of shrinkproof mortar or otherwise constructed to ensure watertightness.
- 3.10 Use gasketed PVC manhole sleeve on all PVC pipe at connections to manholes. Sleeve shall be type as manufactured by Vasallo, or equal.
- 3.11 Where the difference in the invert elevation of two or more lines intersecting in one manhole is 24 inches or more, construct a drop manhole. Drop manholes shall be similar in construction to standard manholes except that a drop connection of pipe and fittings of the proper sizes and materials shall be constructed outside the manhole and supported by 3,000 psi concrete as indicated by the standard drawings.
- 3.12 Place backfill by hand around the manhole and to a distance of at least one (1) pipe length into each trench, and tamp with selected material up to an elevation of twelve 12 inches above the crown of all entering pipes. Continue backfilling in accordance with the requirements for trench backfilling.
- 3.13 Each manhole shall be vacuum tested immediately after installation or rehabilitation and prior to backfilling. No standing water shall be allowed in the manhole excavation which may affect the accuracy of the test. All lifting holes and exterior joints shall be filled and pointed with an approved non-shrink mortar. All pipes and other openings into the manhole shall be suitably plugged in such a manner as to prevent displacement of the plugs while the vacuum is drawn. Installation and operation of the vacuum equipment and indicating devices shall be in accordance with equipment specification and instructions provided by the manufacturer. The test head may be placed in the cone section of the manhole. The rim to cone joint is not usually tested. A vacuum of 7.5 inches of mercury shall be drawn. The time for the vacuum to drop to 6.5 inches shall be recorded. Acceptance for four (4) feet diameter manholes shall be defined as when the time to drop one (1) inch meets or exceeds the following:

<u>Manhole Depth</u>	<u>Time to Drop One (1) Inch</u>
10 feet or less	75 seconds
10 feet to 15 feet	90 seconds
15 feet to 25 feet	105 seconds

For manholes five (5) feet in diameter, add an additional 15 seconds. For manholes six (6) feet in diameter, add an additional 30 seconds. If the manhole fails the test, necessary repairs shall be made and the vacuum test repeated until the manhole passes the test. If the manhole joint mastic or gasket is displaced during the vacuum test, the manhole shall be disassembled, the seal replaced, and the manhole re-tested.

END OF SECTION

### PART 1. GENERAL

- 1.1 This section covers all process piping in the Water Treatment Plant, and in the yard at the plant, but excludes all water supply and waste piping (refer to other sections) to be installed inside and within five (5) feet outside building walls that is shown on the mechanical/plumbing drawings. This section also excludes all gravity sewer line specified in Section 02722, Gravity Sewer and all water lines specified in Section 02713, Water Lines. All plant and yard piping shall be ductile iron, unless shown otherwise on the drawings.
- 1.2 The Contractor shall be responsible for safely storing materials needed for the work that have been accepted by him until they have been incorporated into the completed project. Keep the interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.
- 1.3 Wherever reaction blocking, hangers, strapping, and supports are necessary in the opinion of the A/E, it shall be considered an integral part of the plant and yard piping work, and no separate payment shall be made.
- 1.4 The material of all pipe and fittings shall be ductile cast iron unless otherwise shown or noted on the drawings.
- 1.5 On the drawings, the pipe and fittings associated with pumping and mechanical equipment are shown only to give a general idea of the piping arrangement. Submit shop drawings of pipe and fittings that are prepared using equipment sizes and dimensions obtained from actual measurement or from approved or prepared shop drawings of the equipment concerned and also prepared using the elevations of pipe or structures shown on the drawings. Refer to Section 01305, Equipment Submittals, for the requirements of shop drawing submittals.
- 1.6 Refer to other sections for items affecting plant and yard piping. Coordinate this work with that specified by other sections for timely completion.
- 1.7 Shop drawings are required for all products specified in this Section.

## PART 2. PRODUCTS

### 2.1 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile cast iron pipe (hereinafter called ductile iron pipe) shall be made of good quality ductile iron that meets the requirements for the tensile strength of nodular iron castings tested in accordance with ASTM E8.
- B. All ductile iron pipe for underground service shall be plain end with standardized mechanical joints. Pipe joints that will remain exposed after construction shall be flanged unless otherwise shown on the drawings.
- C. Ductile iron pipe shall be centrifugally cast in metal or sand-lined molds and shall conform to the specifications of ANSI A21.51/AWWA C151. It shall be made and tested in accordance with ASTM A339 and shall be subjected to and able to withstand a hydrostatic pressure of 500 psi. The maximum depth of pits shall be half that allowed in the AWWA specifications.
- D. The design barrel thickness shall be that specified by ANSI A21.50/AWWA C150 except that the barrel of all plain end, mechanical joint and push-on, single gasket joint pipe with a diameter of twelve (12) inches or less shall have a wall thickness of Class 52 (or equivalent pressure class) and all pipe with a diameter of 14 inches or more shall have a thickness of Class 51 (or equivalent pressure class).
- E. Centrifugally cast ductile iron pipe with one flange cast on and one flange screwed that otherwise meets the foregoing requirements shall be acceptable as flanged pipe. Flanged ductile iron pipe with threaded flange shall meet the requirements of ANSI A21.15/AWWA C115 and have a wall thickness of Class 53 (or equivalent pressure class). Flanges to be fabricated onto ductile iron pipe shall be ductile iron also. Ductile iron flange pipe, which is to be fabricated, shall be done so by the pipe manufacturer.
- F. The length of each individual piece of ductile iron pipe shipped must be plainly marked on that piece of pipe.
- G. Mechanical joints used shall be in accordance with standard mechanical joints as manufactured by U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal, with glands, gaskets, and bolts furnished and joints shall be made in conformance with the recommendations of the joint manufacturer as approved by the A/E.

- H. The push-on, single gasket joints shall be either Fastite (manufactured by American Cast Iron Pipe Company), Tyton (U.S. Pipe and Foundry Company), Super Bell-Tite (Clow Corporation), or other joints of similar type and equal quality. They shall be UL approved and able to withstand 200 psi of operating pressure. The bell of each pipe shall have a tapered annular opening and a cast or machined retaining groove for the gasket. The gasket groove shall have a flared design so that maximum deflection will be provided. The plain spigot end of the pipe shall be beveled in order to simplify its entry into and centering within the bell and the compression of the gasket. The gasket shall be of high quality vulcanized rubber made in the form of a solid ring to exact dimensions. The design of the gasket groove in the bell of the pipe and the design, hardness, and other properties of the gasket itself shall be such that the joint is liquid-tight for all pressures from a vacuum to a maximum rating of 350 psi of internal liquid pressure. Adequate lubricant shall be furnished with each pipe for the intended installation. This lubricant shall be nontoxic, impart no taste or smell to the water, and have no harmful effect on the rubber gasket. It shall have a consistency that will allow it to be easily applied to the pipe in either hot or cold weather and that will enable it to adhere to either wet or dry pipe.
- I. Standard and special fittings for underground pipe shall be ductile iron. Standard mechanical joint fittings shall be used. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110. Fitting laying lengths shall conform to ANSI A21.10/AWWA C110, short body. Compact body fittings will not be allowed.
- J. The standard mechanical joint fittings shall be as manufactured by the U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal.
- K. Restrained pipe and fittings, where specified or shown on the drawings, shall be ductile iron. Retainer glands and similar devices will not be allowed in such cases unless otherwise noted or shown on the drawings.
- L. Restrained mechanical joint pipe shall be Clow Corporation Locked Mechanical Joint, U.S. Pipe and Foundry Company Lock Type Mechanical Joint, or equal.
- M. Restrained push-on pipe shall be American Cast Iron Lok-Ring or Clow Corporation Super Lock for all pipe sizes, U.S. Pipe and Foundry Company Lok-Tyte for pipe sizes 14 inches and larger, or equal,
- N. Flanged fittings and other specials shall be of ductile iron and shall be manufactured to ANSI A21.10/AWWA C110 or ANSI B16.1 specifications for a minimum water working pressure of 250 psi. The flanges of pipe, fittings, and specials shall be drilled to standard 125 pound template, unless otherwise shown on the drawings. Flanged pipe and all fittings shall be supplied with gaskets and bolts and, unless otherwise specified, be as manufactured by U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal.



- O. Coatings and Linings of Ductile Iron Pipe and Fittings: Buried pipe and fittings shall be given an outside bituminous coating as stipulated in the ANSI specifications referred to above. Pipe embedded in corrosive earth or water shall be fully encased in an eight- (8) mil thick polyethylene sleeve in accordance with ANSI A21.5/AWWA C105.
- P. Pipe and fittings that will be exposed after construction shall be primed with an acceptable primer and painted in accordance with Section 09900, Painting.
- Q. Pipe and fittings shall be lined with enameling or a thin cement lining as specified in ANSI A21.4/AWWA C104; this lining is to be furnished at no extra cost. In addition, a bituminous seal coat or asphalt emulsion spray coat approximately one (1) mil thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices.
- R. The pipe manufacturer shall furnish the A/E a certificate of inspection, sworn to by the factory inspector in the presence of a notary public, stating that the pieces of pipe in the shipment were made and tested in accordance with ANSI A2.1J51 and that they were subjected to and withstood a hydrostatic pressure of 500 psi. Each statement shall give the number of pieces of pipe, and the identification number of each piece of pipe making up the shipment. In addition, the weight of each individual piece of pipe making up the shipment shall be listed opposite the identification number of each pipe length and attached to the certificate of inspection.

## 2.2 PVC PRESSURE PIPE AND FITTINGS

- A. Unless noted otherwise on the drawings, all plastic pressure pipe shall be made from Class 12454-B polyvinyl chloride plastic (PVC 1120) as defined by ASTM D1784.
- B. All Class 200, 250, or 315 pipe shall have NSF approval and be manufactured in accordance with ASTM D2241. The following tests shall be run for each machine on each size and type of pipe being produced, as specified below:
  - 1. Flattening Test: once per shift in accordance with ASTM D2412. Upon completion of the test, the specimen shall not be split, cracked, or broken.
  - 2. Acetone Test (Extrusion Quality Test): once per shift in accordance with ASTM D2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the tests.

3. Quick Burst Test: once per 25 hours in accordance with ASTM D1599.

SDR	Pressure Rating	Minimum Bursting Pressure, psi
13.5	315	1,200
17	250	1,000
21	200	800

- 4 Impact Tests: for pipes six (6) inches in diameter and larger, once per shift in accordance with ASTM D2444; for pipe four (4) inches in diameter and smaller, once each two (2) hours in, accordance with ASTM D2444.
- 5 Wall Thickness and Outside Dimensions Tests: once per hour in accordance with ASTM D2122
- 6 Bell Dimensions Test: once per hour in accordance with ASTM D3139.
- C. If any specimen fails to meet any of the above mentioned tests, all pipe of that size and type manufactured between the test periods must be scrapped and a full set of tests rerun.
- D. Furnish a certificate from the pipe manufacturer stating that he is fully competent to manufacture PVC pipe of uniform texture and strength and in full compliance with these specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer's equipment and quality control facilities must be adequate to ensure that each extrusion of pipe is uniform in texture, dimensions, and strength. Also furnish a certificate from the manufacturer certifying that the pipe; furnished for this project meets the requirements of these specifications.
- E. All pipe shall be manufactured in the United States of America. The same manufacturer shall make all pipe for any one project.
- F. All four (4) inch and six (6) inch diameter pipe may be furnished in the manufacturer's standard laying lengths of 20 feet, 38 feet, or 40 feet. Pipe eight (8) inches and larger shall be furnished in 20 feet lengths. The Contractor's methods of storing and handling the pipe shall be approved by the A/E. All pipe shall be supported within five (5) feet of each end; in between the end supports, there shall be additional supports at least every 15 feet. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipes out along the proposed routes will not be allowed.

- G. Certain information shall be applied to each piece of pipe. At the least, this shall consist of:
1. Nominal size
  2. Type of material
  3. SDR or Class
  4. Manufacturer
  5. NSF Seal of Approval
- H. Pipe that fails to comply with the requirements set forth in these specifications shall be rejected.
- I. The PVC pipe shall have push-on joints designed with grooves in which continuous molded rubber ring gaskets can be placed. Gaskets shall be made of vulcanized natural or synthetic rubber; no reclaimed rubber will be allowed. The gaskets shall be of the manufacturer's standard design dimensions and of such size and shape as to provide a positive seal under- all combinations of joint and gasket tolerance. The gasket and annular groove shall be designed and shaped so that when the joint is assembled, the gasket will be radially compressed to the pipe and locked in place against displacement, thus forming a positive seal.
- J. The spigot end of each pipe shall beveled so that it can be easily inserted into the gasket joint, which in turn shall be designed so that the spigot end may move in the socket as the pipe expands or contracts. The spigot end shall be striped to indicate the distance into which it is to be inserted into the socket. Each joint shall be able to accommodate the thermal expansions and contractions experienced with a temperature shift of at least 75 degrees F.
- K. Enough lubricant shall be furnished with each order to provide a coat on the spigot end of each pipe. This lubricant shall be nontoxic, impart no taste or smell to the water, have no harmful effect on the gasket or pipe material, and support no bacterial growth. The lubricant containers shall be labeled with the manufacturer's name.
- L. Joints shall be manufactured in accordance with ASTM D3139 except that the thickness of the bell shall be, as a minimum, equal to that of the barrel. Joints shall be either integral bell and ring joints with rubber compression gaskets as manufactured by the Clow Corporation, Johns-Manville, or Vulcan Plastic Corporation; twin gasket couplings as manufactured by the Certain- Teed Products Corporation; or equal. However, the same manufacturer must make the pipe and bell.

- M. Standard and special fittings shall be ductile iron. Use standard mechanical joint fittings. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110. The gaskets shall be duck tipped transition gaskets for use with PVC pipe.
- N. Fittings shall be lined with enameling or a thin cement lining as specified in ANSI A21.4/AWWA C104; this lining shall be furnished at no extra cost. In addition, a bituminous seal coat or asphalt emulsion spray coat approximately one (1) mil thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices.
- O. Fitting laying lengths shall conform to ANSI A21.10/AWWA C110.
- P. Fittings shall be in accordance with the standard mechanical joint fittings manufactured by the U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal.

### 2.3 MISCELLANEOUS PIPE AND PIPING ACCESSORIES

- A. Copper Pipe and Tubing: Copper pipe in buildings and structures and other pipe that will remain exposed after construction shall be Type L, hard drawn. Copper tubing shall conform to ASTM B88 for seamless copper water tube with copper or brass fittings unless otherwise called for on the drawings. Copper pipe for underground service shall be Type K.
- B. Red Brass Pipe and Fittings: Brass pipe shall conform to ASTM B43 for seamless red brass pipe. Fittings shall bronze screwed fittings conforming to ASTM B61.
- C. Wall Sleeves or Wall Pipe: Where a pipe passes through concrete wall, furnish and install mechanical joint cast iron wall sleeve or mechanical joint or flanged wall pipe as shown on the drawings. Use wall Sleeves only at the locations shown on the drawings and as approved by the A/E. Where wall sleeves are used, run pipe continuously through walls, and provide a joint within three (3) feet outside the wall. Formed openings in concrete walls for inserting ductile iron piping will not be allowed. Accurately locate and securely fasten wall pipe sleeves in place before pouring concrete. Use wall sleeves in locations where small piping and electric wiring connects with or passes through concrete walls, and caulk watertight.

- D. Schedule 40 and Schedule 80 Polyvinyl Chloride (PVC) Pipe and Fittings:
1. Scope: This covers requirements for Schedule 40 and Schedule 80 PVC pipe and fittings made from Type 1 PVC. Standard valves are also included. Service temperatures shall not exceed 140 degrees F.
  2. Materials:
    - a. Pipe, fittings, and valves shall be manufactured from a PVC compound, which meets the requirements of Type 1, Grade 1 PVC as outlined in ASTM D1784. A Type 1, Grade 1 compound is characterized as having the highest requirements for mechanical properties and chemical resistance.
    - b. The compound from which pipe is produced shall have a design stress rating of 2,000 psi at 73 degrees F listed by PPL
    - c. Materials from which pipe, fittings, and valves are manufactured shall have been tested and approved for conveying potable water by the NSF.
  3. Pipe: Pipe shall conform to the requirements of ASTM D1785, Figure 0011210.
  4. Fittings: Fittings shall conform to the requirements of ASTM D2467 for socket type and ASTM D2464 for threaded type.
  5. Solvent Cement: All socket type connections shall be joined with primer, Figure 411, and PVC solvent cement Figure 401, complying to ASTM D2564 by Plastic Piping Systems, Inc., Piscataway, New Jersey.
  6. Installation Procedures: Installation practices, including support spacing, compensation for expansion and contraction and solvent Welding, shall comply with the manufacturer's printed recommendations.
  7. Potable Water Approval: Pipe, fittings, and valves shall be listed by NSF indicating that they have been tested and approved by NSF for conveying potable water. Pipe and fittings must bear the NSF seal.
  8. Uniformity: To ensure installation uniformity, all piping system components shall be the products of one manufacturer.
- E. Pipe Hangers, Supports, Anchors, and Braces

1. The contractor shall provide and install rigid non-corrosive supports and hangers at all piping systems to prevent loosening under vibration. Where shown on the drawings, provide special supports as detailed thereon. The Contractor shall be responsible for necessary supports and bracing of piping systems to prevent their damage during construction or normal operation. Pipe Hangers, Supports, Anchors, and Braces shall be considered incidental to installation of the piping and is to be part of the lump sum project of the Water Treatment Plant and no pay item will be allowed for this work.
  2. Securely support horizontal runs of pipe. Support spacing's shall not exceed ten (10) feet for pipes larger than two (2) inches in diameter.
  3. Support suspended ductile iron pipe with adjustable single rod carbon steel clevis hangers similar to Grinnell Figure 260, Fee and Mason Figure 104, or equal. For other suspended piping, use adjustable split ring swivel hangers similar to Grinnell Figure 104, Fee and Mason Figure 199, or equal.
  4. Support horizontal pipe near the floor with one of the following, as indicated on the drawings:
    - a. Pipe Saddle Support: Grinnell Figure 258, Fee and Mason Figure 95 with nipple and flange, or equal.
    - b. Adjustable Pipe Saddle Support: Grinnell Figure 264, Fee and Mason Figure 291, or equal.
    - c. Pipe Stanchion Saddle Support: Grinnell Figure 259, Fee and Mason Figure 259, or equal.
  5. Pipe anchors shall consist of heavy steel collars with lugs and bolts for clamping and attaching anchor braces, unless otherwise shown on the drawings. Install anchor braces in the most effective manner to secure the desired results, using turnbuckles where necessary. Do not attach supports, anchors, or stays in places where such anchors will injure the construction either in installation or by the weight or expansion of the pipeline. Submit detailed drawings of pipe anchors to the A/E for approval before installation.
- F. Steel and Rubber Couplings: Steel couplings, where shown on the drawings, shall be Dresser Type 38, Smith and Blair Type 421, steel couplings for ductile iron pipe, or equal.

- G. Rubber Expansion Joint/Couplings: Where shown on the drawings, these shall be suitable for the service pressure in the line where used and for normal temperatures. Rubber expansion joints shall be supplied complete with steel retaining rings and shall be drilled for coupling to the pipe flanges they are used with. Rubber expansion joints shall be standard single arch joints and shall be filled arch type when used for wastewater service.
- H. Pressure Gauges
  - 1. Unless otherwise specified, pressure gauges shall be oil filled, 4-1/2 inches size with bronze bourdon tube, black phenolic case, 1/4 inch NPT bottom connection, white dial, and one percent (1%) of full-scale accuracy. Gauges used on pump discharges shall be calibrated in pounds from zero to twice the maximum pump head. Use compound gauges having a range of 30 inches Hg x 30 psig on the pump suction.
  - 2. Gauges for use on clear water service shall be equipped with a 1/4-inch NPT brass gauge cock and a 1/4-inch brass snubber. Snubber shall be a Ray Model 1.
  - 3. Gauges for use on wastewater, sludge, or chemical feed service shall be equipped with a gauge cock, capillary bleeder, and diaphragm seal unit and filled with silicone oil.

### PART 3. EXECUTION

#### 3.1 LAYING PIPE IN THE TRENCH

- A. Lay piping to and maintain at the lines and grades required by the drawings. All fittings, valves, and hydrants shall be at the required locations, the spigots centered in the mechanical joint bells, and all valves and hydrant stems plumb.
- B. Unless otherwise indicated by the drawings, all water pipes shall have at least 30 inches of cover. All pipe shall contain a 6-inch gravel bedding and shall be backfilled to the top of trench with clean stone. No departure from this policy shall be made except with the approval of the A/E. Stone cost shall be incidental to pipe laying within the yard of Contact "A" Water Treatment Plant, and shall be part of the lump sum cost for each contact.
- C. Provide and use tools and facilities that are satisfactory to the A/E and that will allow the work to be done in a safe and convenient manner. All pipe, fittings, valves, and hydrants are to be unloaded from the trucks using suitable tools and equipment. Use a derrick, ropes, or other suitable tools or equipment to lower all pipe, fittings, valves, and hydrants

into the trench one (1) piece at a time. Lower each piece carefully so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances drop or dump line materials into the trench.

- D. Any pipes strung out along the route of the proposed lines before the actual installation of those lines is due to take place shall not be lowered into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated within them. Remove all unnecessary material from the ends of each pipe. Before any pipe is laid, brush and wipe clean the outside of its spigot end and the inside of its bell, and leave dry and oil-free.
- E. Take every precaution to keep foreign material from getting into the pipe while it is being placed in the line. If the crew laying the pipe cannot put it into the trench and in place without allowing earth to get inside, then put a heavy, tightly woven canvas bag of suitable size over each end of the pipe, and leave in place until it is time to connect that pipe to the one adjacent to it.
- F. Place no debris, tools, clothing, or other materials in the pipe during laying operations.
- G. After a length of pipe has been placed in the trench, center the spigot end in the bell of the adjacent pipe, and then insert to the depth specified by the manufacturer and bring to the correct line and grade. Secure the pipe in place by tamping an approved backfill material around it.
- H. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, carefully grade the bottom of the trench so that each pipe barrel will rest on a solid foundation for its entire length.
- I. Whenever pipe laying is not in progress, close the open ends of pipe either with a watertight plug or by other means approved by the A/E. If the joints of any pipe in the trench cannot be completed until a later time, caulk them with packing in order to make them as watertight as possible; this shall be done not only at the end of each working day but also before work is stopped for lunch periods, bad weather, or any other reason. If there is water in a trench, leave this seal in place until the trench has been pumped completely dry.
- J. Cut pipe so that valves, fittings, or closure pieces can be inserted in a neat and workmanlike manner and without any damage to the pipe. Follow the manufacturer's recommendations concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis.
- K. Lay pipe with the bell ends facing in the direction of laying unless otherwise directed by the A/E.



- L. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor that recommended by the pipe manufacturer, and shall be approved by the A/E.
- M. Lay no pipe in water or when it is the A/E's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, its use is considered incidental to the project, and no separate payment will be made for its use.
- N. Where a water line crosses over a sanitary sewer, use a full joint of pipe with a standard mechanical joint, and center over the sewer. Where a water line is to be parallel to a sanitary or storm sewer, lay it at least ten (10) feet from the sewer. If it is not practical for the water and sewer lines to be separated as described above, then lay the water line at least 18 inches above the top of the sewer. A concrete cap may be required as directed by the A/E and no additional cost will be allowed for this concrete cap.
- O. Join all pipe in the exact manner specified by the manufacturer of the pipe and jointing materials.

### 3.2 INSTALLATION OF FLANGED PIPE

- A. Install flanged ductile iron pipe in the manner specified above except that the faces of the flanges shall be carefully centered and the sections adjusted to proper line and grade before the flange bolts are tightened. Place gaskets in position without damage. Discard and replace any gasket damaged in the process. Attach gaskets to the flange with rubber gum before the joint is made up in a manner that will prevent displacement. After the pipes have been properly centered and adjusted to true line and grade, firmly bolt them together, taking care to tighten all nuts around the flange to the same degree of pressure.
- B. Unless otherwise shown on the drawings, all flanged pipe shall extend five (5) feet from all structures.

### 3.3 HYDROSTATIC TESTS FOR PRESSURE MAIN

- A. Pressure Test
  - 1. After pipe has been installed, subject it or any valved section thereof to a pressure of 200 psi.
  - 2. The duration of each pressure test shall be at least one (1) hour.

3. Slowly fill each valved section of pipe with water and apply the specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) with a pump connected to the pipe in a manner satisfactory to the A/E. Furnish the pump, pipe, connections, gauges, and all necessary apparatus.
4. Before applying the specified test pressure, expel all air from the pipe. If hydrants or blowoffs are not available at high places, make the necessary taps at the points of highest elevation before elevation before testing, and insert plugs after the test has been completed.
5. Carefully examine all exposed pipes, fittings, valves, and hydrants during the test- Remove any cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this pressure test, and replace with sound material in the manner specified Repeat the test until the results are satisfactory to the A/E.

B. Leakage Test

1. Conduct the leakage test after the pressure test has been satisfactorily completed. Furnish the pump, pipe, connections, gauges, measuring devices, and all other necessary apparatus as well as all necessary assistance to conduct the test.
2. The duration of each leakage test shall be two (2) hours; during the test, subject the main to a pressure of 200 psi.
3. Leakage is defined as the amount of water, which must be supplied to the newly laid pipe or any valved section in order to maintain the specified leakage test pressure after the pipe has been filled with water and the air, expelled.
4. No pipe installation will be accepted until the leakage is less than the number of gallons per two- (2) hour period listed below:

PIPE SIZES	GALLONS PER 1,000 FEET OF PIPE
2-1/4 Inches and smaller	0.2
3 inches	0.5
4 inches	0.6
6 inches	0.9
8 inches	0.2
10 inches	1.5
12 inches	1.9

14 inches	2.2
16 inches	2.6
18 inches	2.9
20 inches	3.2
24 inches	3.8

5. Should any test of pipe laid disclose leakage greater than that specified, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance.

### 3.4 DISINFECTION OF POTABLE WATER LINES

- A. During construction, take precautions to protect pipe interiors, fittings, and valves against contamination. When pipe laying is not in progress (e.g., at the end of the day's work), place watertight plugs in the ends of all pipe already in the trench; if water accumulates in the trench, leave the plugs in place until the trench is dry. Complete the joints of all pipe in the trench before stopping work for any reason.
- B. If dirt or other foreign material that has gotten into a pipe will not, in the opinion of the A/E, be removed by flushing, clean the interior of the pipe, and swab with a disinfecting solution of five percent (5%) hypochlorite.
- C. Make water flows from the existing distribution system or some other source approved by the A/E into the newly laid pipeline, and add chlorine to it. Feed water into the pipe, and chlorine into the water, at constant, measured rates so proportioned that the chlorine concentration in the water in the pipe is kept at a minimum of 50-mg/1 available chlorine. To ensure that this concentration is maintained, measure the chlorine residual at regular intervals.
- D. Table I shows how much chlorine is needed for each 100 feet of line for pipes of various diameters. A one percent (1%) chlorine solution may be prepared either with one (1) pound of calcium hypochlorite for each 8.5 gallons of water or with sodium hypochlorite.

TABLE I  
CHLORINE REQUESTED TO PRODUCE A 50 MG/L CONCENTRATION IN 100  
FEET OF PIPE, BY DIAMETER

Pipe Size (Inches) (Pounds)	100% Chlorine (Gallons)	1% Chlorine Solutions
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.328	3.96
16	0.428	5.12
18	0.540	6.48
20	0.680	8.00
24	0.980	11.52

- E. While the chlorine is being applied, manipulate valves so that the treatment dosage will not flow back into the line that is supplying the water. Continue the application of chlorine until the entire line being treated is filled with the chlorine solution. Then retain the chlorinated water in the line for at least 24 hours, during which time all valves and hydrants in the line being treated shall be operated so that appurtenances can also be disinfected. After 24 hours, the treated water shall have a chlorine concentration of at least 25 mg/1 throughout the line.
- F. After the applicable retention period, flush the heavily chlorinated water from the line until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system or less than one (1) mg/1. Perform such flushing only at sites where there is adequate drainage.
- G. The velocity of the water used to flush a line shall be at least 2.5 fps. The flow rates required to produce this velocity in various sizes of pipe are shown in Table II.

TABLE II

REQUIRED OPENINGS TO FLUSH PIPELINES  
(40 PSI RESIDUAL PRESSURE)

Pipe Size (Inches)	Flow Required To Produce 2.5 fps Velocity (g pm)	Orifice Size (Inches)	Hydrant Outlet Nozzles Size	
			Number	(Inches)
4	100	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2
12	880	2-13/16	1	2-1/2
14	1,200	3-1/4	2	2-1/2
16	1,565	3-5/8	2	2-1/2
18	1,980	4- 3/16	2	2-1/2
20	2,440		2	2-1/2
24	3,470		2	2-1/2

- H. Once a line has been flushed, test to make certain that the residual chlorine in the water is within acceptable limits.
- I. It must be noted that flushing is no substitute for taking preventative measures before and during the laying of water lines. Certain contaminants- especially those in caked deposits—are difficult or even impossible to remove by flushing, no matter how high the velocity. Furthermore, in pipes with diameters of 16 inches or more, it can be difficult to achieve even the minimum recommended flushing velocity of 2.5 fps.

### 3.5 BACTERIOLOGICAL TESTS

- A. After a potable water line has undergone final flushing but before it is placed into service, collect a sample for bacteriological testing from the end of that line. In the case of extremely long lines, take additional samples if the A/E so directs.
- B. Collect these samples in sterile bottles treated with sodium thiosulfate. Do not use a hose or fire hydrant to collect samples. One suggested sampling method is to install a standard corporation cock in the line with a copper tube gooseneck assembly; after the samples have been taken, the gooseneck assembly can be removed and retained for later use.
- C. Take the samples collected to an approved laboratory to be tested for bacteriological quality in order to determine if they contain any coliform organisms. If the initial disinfection fails to produce satisfactory samples, repeat disinfection until satisfactory samples are obtained.
- D. When the samples tested are found to be satisfactory, the water line

may be placed in service.

### 3.6 DISINFECTION PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING LINES

- A. The procedure outlined above apply primarily to cases in which the lines are wholly or partially dewatered.
- B. However, leaks or breaks that are repaired with clamping devices while the lines remain full of water under pressure present little danger of contamination and require no disinfection.
- C. When an existing line is opened, whether by accident or design, the excavated area could be wet and contaminated because of the presence of sewers nearby. The danger of contamination from such pollution can be lessened if liberal quantities of hypochlorite are applied to the open trenches. It is better to use tablets for disinfection in such cases because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation site.
  - 1. Swab the interior of all pipes and fittings (particularly couplings and tapping sleeves) that are to be used in repairing an existing line with a solution of five- percent (5%) hypochlorite before installing them.
  - 2. The most practical means of removing contamination introduced into a line during repairs is to give the line a thorough flushing. If the locations of valves and hydrants make it possible; flushing in both directions is recommended. Start flushing as soon as repairs are completed, and continue until all discolored water is eliminated.

### 3.7 CLEANUP

- A. After completing each section of the piping system, remove all debris and all construction materials from the work site. Then grade and smooth over the surface on both sides of the line. Leave the entire area clean and in a condition satisfactory to the A/E.

END OF SECTION

PART 1. GENERAL

- 1.1 This section covers all valves and hydrants specified under Section 02610, Plant and Yard Piping, for Contract "A" Water Treatment Plant that are to be installed in the process and yard piping, excluding all water supply and waste piping (refer to other sections) that is to be installed inside and within five (5) feet outside building walls and/or that is shown on the mechanical/plumbing drawings or specified under sections concerning HVAC and plumbing (Division 15). This section also covers all valves to be installed on Finished Water Transmission Lines.
- 1.2 Furnish all materials and equipment and install the valves at the locations shown on the drawings.
- 1.3 Where required for satisfactory operation of valves, provide extension stems, stem guides, cast iron valve boxes, floor boxes, floor stands, bench stands, chain wheel with chain (valve centerline greater than six (6) feet above a walking surface), handwheels, and other valve appurtenances. Underground extension stems shall be complete with guide bearings, wrench nut, and tee handle wrench. All valve stems and machinery stuffing boxes shall be packed with material selected for the service intended. Maintain all packing until final acceptance by the Owner.
- 1.4 Safely store materials needed for the work that has been received at the project site until they have been incorporated into the completed project. Store the materials in strict accordance with the instructions for storage as specified by each valve and hydrant supplier and manufacturer.
- 1.5 Shop Drawings will be required for all valves and hydrants hereinafter specified. Refer to Section 01305, Equipment Submittals, for the requirements of shop drawing submittals. Valves proposed for use at each location shall be identified in the submittals by the valve type, fluid service and location (sheet reference).
- 1.6 All valves and hydrants as specified below will not necessarily be used for every project. Refer to the project drawings for valves to be used on this job.
- 1.7 Refer to other sections for items affecting valves and hydrants. Coordinate this work with that specified by other sections for timely completion.

## PART 2. PRODUCTS

### 2.1 GATE VALVES

- A. Gate valves of the sizes, classes, and types required shall be furnished with flanged, mechanical joint or hub ends as shown on the drawings and shall conform to AWWA C500 as extended and modified herein. Gate valves shall be tested at double their working pressure. Gate valves shall open by being turned counterclockwise.
- B. If for inside service, the exterior surface of the valve, except finished flanges, shall be painted with one priming coat of TNEMEC 77 Chem Prime, Inertol 621 or approved equal primer. Products containing lead are prohibited. Exterior or buried valves shall be coated with black asphaltum varnish.
- C. The valves shall be nonrising stem (NRS), with cast or ductile iron body and bonnet, bronze mounted in accordance with AWWA C500. As a minimum, the disc seat rings, body seat rings, stem nut, stem, and wedge shall be of bronze.
- D. In flanged valves, the body shall have end flanges dimensioned and machined to the ANSI 25 pound standard for 25 pound and 50 pound valves and dimensioned and machined to the ANSI 125 pound standard for 75 pound through 200-pound valves, with flanges drilled to the 125 pound standard. Where noted as Class 250 pound, valves shall be so rated, and flanges shall be drilled and with raised face in accordance with ANSI B16b, 250 pound.
- E. The body flange that connects to the bonnet shall be machined and drilled.
- F. The stem, collar bearing recess, stem opening, top of the bonnet, and flange that bolts to the body flange shall all be machined.
- G. The discs shall be of cast iron. Dovetail grooves shall be machined in the discs to receive the bronze seat ring, which shall be rolled or peened into the grooves.
- H. The stem shall be of forged or cast bronze with a mechanically upset collar. The stem shall have modified ACME threads. Stem diameters shall comply with the appropriate AWWA Standards. Stem packing on valves twelve (12) inches and smaller shall be of the O-ring type unless otherwise specified.
- I. The stem nut shall be of cast or forged bronze and shall have threads machined to fit the stem.



- J. Body seat rings shall be of cast bronze threaded and screwed into the body, after which they shall be machined on the face. The width of the body seat ring shall be sufficient to result in a bearing pressure of the gate on the body seat ring of not more than 2,000 psi under a hydrostatic pressure of 300 psi.
- K. Disc seat rings shall be of cast bronze of such composition that they can be rolled or peened into dovetailed grooves machined in the disc, after which they shall be machined on the face. They shall be wider than the body seat rings. The valves shall be equipped with an internal wedging device of the wedge or spreader type which, in closing the valve, will operate when the discs reach a position opposite the ports to spread the discs apart and force them against the seat rings in the body. In the wedge type; the wedges shall be of solid bronze and the hooks that actuate the wedges shall be of cast iron. In the spreader type, at least one wedging surface shall be bronze faced.
- L. The stuffing box shall be of cast iron and shall be machined on the bottom to fit the top of the bonnet and to provide the upper thrust surface for the stem collar. The stem opening through the stuffing box shall be machined to a close clearance with the stem to provide the lateral bearing for the stem.
- M. The gland assembly, where used, shall be cast iron. The gland bolts shall be of steel with steel nuts.
- N. The bolts connecting the body and bonnet flanges shall be of commercial steel with square heads and hexagon nuts.
- O. The gaskets between the body and bonnet and the stuffing box flanges shall be 1/32 inch thick paper equivalent to Endena. Gaskets containing asbestos in any form will not be acceptable.
- P. There shall be cast on the body or bonnet of the valve the manufacturer's name, monogram, or initials; the valve's pressure rating; the size of the valve; and the year of manufacture.
- Q. The valves shall be carefully inspected for any defects and shall be operated through the full travel to ensure free and perfect functioning of all operating parts. Each valve shall be subjected to a hydrostatic test: the shell to the rated pressure and the seals to the rated working pressure.
- R. Furnish a manufacturer's certificate indicating that the required tests have been made and the results of the tests conform to the requirements of these specifications.

## 2.2 SWING CHECK VALVES

### A. Swing Check

1. Swing check valves shall be iron body, bronze mounted, with seat rings, faces, and hinge pins suitable for operation in horizontal or vertical lines. Unless otherwise shown on the drawings, operation shall be by means of an outside lever and weight.
2. A removable cover shall be provided for the removal of internal parts without necessitating the removal of the valve from the line. The high point of the valve shall be tapped and equipped with a plug. When shown on the drawings, a valve or curb cock for the removal of air shall be provided. Unless otherwise shown, all check valves shall be flanged with flanges dimensioned and drilled to the ANSI 125 pound standard.

### B. Nonslam Type Swing Check

1. The vertical turbine pumps at the Water Treatment Plant and Intake - pumps will require nonslam swing check valves to be a heavy duty body constructed of high-strength cast iron or cast steel body conforming to ASTM A126 Class B with integral flanges, faced and drilled per ANSI B16.1 Class 125 and be suitable for horizontal or vertical installation. The valve shall also have a bronze or stainless steel seat ring, a noncorrodible shaft for attachment of weight and lever, and complete noncorrodible cushion chamber.
2. The valve body shall be the full waterway type, designed to provide a net flow area of not less than the nominal inlet pipe size when swung open no more than 25 degrees. The valve shall have a replaceable stainless steel body seat.
3. The valve disc shall be cast iron and with a renewable resilient seat ring of rubber or other suitable material, held in place by follower ring and stainless steel screws.
4. The disc arm shall be ductile iron or steel, suspended from and keyed to an austenitic stainless steel shaft which is completely above the waterway and supported at each end by heavy bronze bushings. The shaft shall rotate freely without the need for external lubrication. The shaft shall be sealed where it passes through the body by means of a stuffing box and adjustable packing. Simple o-ring shaft seals are not acceptable.

5. The valve shall be supplied with an outside lever and adjustable counterweight to invite closure. Final closure shall be dampened by means of a single, side-mounted bronze air-cushioned assembly directly mounted to the valve body on machined pads. The amount of cushioning shall be easily adjusted without the need for pre-charged air chambers. Commercial air cylinders, which pivot and/or are attached with fabricated brackets, are not acceptable.
6. It shall absolutely prevent the return of water, oil, of gas back through the valve when the inlet pressure decreases below the delivery pressure. The valve shall be tight seating and shall operate without hammer or shock.
7. The seat ring shall be renewable and shall be securely held in place by a threaded joint.
8. The cushion chamber shall be attached to the side of the valve body externally and constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The cushioning shall be by air, and the cushion chamber shall be arranged so that the closing speed can be adjusted to meet the service requirements.
9. The valve shall swing open smoothly at pump start and close quickly and quietly upon pump shutdown to prevent flow reversal. When closed, the valve shall seat drop tight.
10. A removable cover shall be provided for the removal of internal parts without necessitating the removal of the valve from the line. The high point of the valve shall be tapped and equipped with a plug. When shown on the drawings, a valve or curb cock for the removal of air shall be provided. Unless otherwise shown, all check valves shall be flanged with flanges dimensioned and drilled to the ANSI 150 pound standard.
11. The valve shall be GA Industries, Inc. Figure 250-D or 250-U or an approved equal. The 250-D or equivalent shall be utilized at the backwash pump. The 250-U or equivalent shall be utilized at the high service pumps.

### 2.3 SMALL VALVES (EXCEPT FOR CHEMICAL/SOLUTION PIPING)

- A. All small valves as provided and installed by the Contractor shall be suitable for the use and conditions of their intended use. Where small valves are provided as a part of an equipment package, the valves shall be as recommended by the equipment manufacturer/supplier.

- B. Unless otherwise shown on the drawings, gates valves two (2) inches and smaller shall be all-bronze, single wedge disc, nonrising stem, and handwheel operated. Such valves shall be Crane No. 438, Lunkenheimer Figure 2129, or equal, for screwed end valves, and Crane No. 1320, Lunkenheimer Figure 2133, or equal, for solder joint valves.
- C. Check valves two (2) inches and smaller shall be bronze body, composition disc, with screwed ends, similar to Crane No. 34-1/2, Lunkenheimer Figure 230-70, or equal.
- D. Standard screwed end globe valves two (2) inches and smaller shall be bronze valves with plug disc and shall be Crane No. 14-1/2 P, Lunkenheimer Figure 73-PS, or equal. Needle point globe valves 3/4 inch and smaller shall be bronze valves similar to Crane No. 88, Jenkins, or equal.

#### 2.4 SOLENOID VALVES

- A. All Solenoid valves shall be of the globe valve type, two (2) way normally closed valves unless otherwise noted on the drawings. These shall be controlled by a 115V, single phase, 60 Hz power supply.

#### 2.5 REDUCED PRESSURE BACKFLOW PREVENTER

- A. The backflow prevention device shall contain a minimum of two (2) independently acting check valves with an automatically operated pressure differential relief valve located between the two (2) check valves and two (2) shutoff valves. It shall be equipped with the necessary appurtenances for testing.
- B. The first check valve shall reduce the supply pressure a predetermined amount so that during normal flow and the cessation of normal flow, the pressure between the checks is less than the supply pressure. In the case of leakage of either check valve, the differential relief valve shall discharge to the atmosphere in order to keep the pressure between the checks less than the supply pressure. When the inlet pressure is two- (2) psi or less, the relief valve shall open to the atmosphere, thereby producing an air gap in the device. Operation shall be completely automatic. All parts must be removable or replaceable without removal of the unit from the line.
- C. The reduced pressure backflow preventer shall be Watts Regulator Series 909 or an approved equal.

#### 2.6 AUTOMATIC WATER AIR RELEASE VALVE

- A. Automatic water air release valves shall consist of air release, air/vacuum, or combination air valves designed to operate on the vertical

turbine pumps' discharge lines or systems. After the air escapes out of the air release valve, the valve shall shut off until more air accumulates in it and the opening cycle repeats automatically.

- B. The water air release valves shall have a body and cover of cast iron conforming to ASTM A48, Class 30, and a compound internal linkage of precision molded delrin conforming to ASTM C2133. The valves shall be either a single body or dual body combination type. Valves sized as indicated shall be Val-Matic Series 800 Single Body and Val-Matic Model 49A Double Body or an approved equal. All internals must be stainless steel conforming to ASTM A240 that positively prevents galvanic action. The float rod shall be long enough to provide an air gap between the linkage and waste level inside the valve that retards waste solids from clogging the linkage. The stainless steel float must withstand a minimum pressure of 1,000 psi.
- C. Each valve shall be complete with hose, two- (2) quick disconnect couplings, blowoff, and shutoff valves to permit backflushing without dismantling the valve. The valve shall be short body, and the height (including the backflushing attachments) shall be not more than 24 inches. The valves shall be two- (2) inches size complete with shutoff valve unless otherwise noted on the drawings.
- D. Process water air release valves shall be as manufactured by Cla-Val, Val- Matic, APCO, Crispin or approved equal.
- E. NOT USED
- F. Air/vacuum valves (valve type and size to be recommended by the pump manufacturer) are to be installed at each vertical turbine pump's discharge line, between the discharge flange and the check valve, as to release air accumulated in the pump column. It is the responsibility of the contractor to install the valve as recommended by the pump manufacturer as to prevent air from hindering the operations, processes, and analyzers at the water treatment plant. No air shall be permitted through the line from the vertical turbine pumps and will not be accepted by the A/E until such provisions or correct air release valves are installed to eliminate such air.
- G. Air release valves will also be required at the locations as indicated on the water treatment plant drawings.

## 2.7 AIR PRESSURE RELIEF VALVES

- A. Air pressure relief valves shall be top outlet, bronze body, adjustable, spring loaded and with screwed ends. The relief pressure setting shall be adjustable in the range of one (1) to five- (5) psi.

## 2.8 MUD VALVES

- A. Plug drain or mud valves shall be cast iron, bronze fitted, nonrising stem. Unless otherwise shown on the drawings, plug drain valves shall be furnished with a two- (2) inches square nut for floor box operation. Seat, disc, or gate ring and valve stem shall be bronze. Extension stems shall be stainless steel and stem guides shall be as specified elsewhere in this section. Valves shall be furnished with spigot or flanged end as shown on the drawings and shall open counter clockwise. Plug drain valves shall be set one (1) inch below the floor and the floor sloped to the opening.

## 2.9 BALL VALVES

- A. Each ball valve for chemical piping systems shall be a top entry ball valve with wedge seat and threaded, true union type, or flanged end connection. The valve body material shall be solid PVC, and seats shall be of Teflon. All valves for chemical piping systems shall be suitable for the intended use and conditions.

## 2.10 BUTTERFLY VALVES AND OPERATORS

- A. Wafer Butterfly Valves: Wafer butterfly valves for air service shall have ductile iron body and blade, shall be suitable for mounting between ANSI 150 pound flanges, unless shown otherwise on the drawings, and shall be metal seated. The valve shall have Type 304 stainless steel stub shafts and taper pin, cast iron bearings, bronze packing nut, and TFE asbestos packing. The valve shall be lever operated with positive lever position locking arrangement.

### B. Butterfly Valves

1. All butterfly valves shall be of the tight closing, resilient seat type. No metal to metal seating surfaces shall be permitted. Valves shall be bubbletight at rated pressures with flow in either direction and shall be satisfactory for applications involving throttling service and/or frequent operation after long periods of inactivity. Valve discs shall rotate 90 degrees from the fully open position to the tight shut position. Valves 20 inches and smaller shall meet the full requirements of AWWA C504 for Class 150B.
2. Valve bodies shall be constructed of cast iron, ASTM A126, Class B, for flanged end valves or ASTM A48, Class 40, for wafer valves. The flange drilling shall be in accordance with ANSI B16.1 for cast iron flanges. A total of two (2) trunnions for shaft bearings shall be integral with each valve body. Body thickness shall be in strict accordance with AWWA C504,
3. Valve discs shall be constructed of alloy cast iron, ASTM A436

Type I (Ni-Resist).

4. Shafts of all valves shall be turned, ground, and polished. Valve shafts shall be constructed of 18-8 Type 304 or Type 316 stainless steel. Shaft diameters must meet minimum requirements established by AWWA C504 for Class 150B.
5. The resilient seating shall be obtained by either of the following two (2) designs:
  - a. Resilient Seat in the Valve Body: Valve seats shall be of a synthetic compound. Valves shall have seats that are simultaneously molded in, vulcanized, and bonded to the body. The seat bond must withstand 75 pounds of pull under test procedure ASTM D429, Method B.
  - b. Resilient Seat Attached to the Valve Disc: The valve disc shall be fitted with a resilient seat of synthetic rubber fixed in place with a retaining ring and cap screws passing through the rubber seat. The seat retaining ring and cap screws shall be of 18-8 stainless steel. The rubber drive shall be replaceable in the field.
6. Valves shall be fitted with sleeve bearings. Bearings shall be corrosion resistant and self-lubricating. Bearing loads shall not exceed 1/5 of the compressive strength of the bearing or shaft material.
  - a. Packing shall be of the self-adjusting Chevron type.
  - b. Valve operators shall conform to AWWAC504.
- C. Manual Operators: Manual operators shall be of the traveling nut, self-locking type and shall be designed to hold the valve in any intermediate position between fully open and fully closed without creeping or fluttering. Operators shall be equipped with mechanical stop limiting devices to prevent overtravel of the disc in the open and closed positions. Valves shall close with a clockwise rotation. Operators shall be fully enclosed and designed to produce the specified torque with a maximum pull of 80 pounds on the handwheel or chainwheel. Operator components shall withstand an input of 450 foot-pounds at the extreme operator position without damage.
- D. Cylinder Operators, Pneumatic
  1. Cylinder operators shall move the valve to any position from fully open

to fully closed when a maximum of 100-psi air or a minimum of 60-psi air is applied to the cylinder. All parts of the cylinder shall be nonmetallic except the cylinder rod, which shall be chromium-plated stainless steel.

2. Rod seals shall be of the nonadjustable, wear compensating type. A rod wiper for removing deposits inside cylinder shall be provided in addition to the external dirt wiper.

E. Butterfly Valve Motor Operators

1. The valve positioners shall be a reversible electric motor type, the speed of which shall be proportional to the error signal or speed called for by the controller.
2. The valve positioner shall provide 75 foot-pounds for four (4) inch diameter and smaller and 300 foot-pounds for six (6) inch diameter and larger torque output. The motor shall be AC reversible to operate from a 120V, single phase, 60 Hz power supply and shall incorporate internal braking to prevent coasting. Position accuracy shall be one (1) part in 1,000. Gearing shall be worm and worm gear to eliminate backdriving by the valve and to provide self-locking in position when the positioner is receiving no signal from the controller. Gearing and motor shall be permanently lubricated. True value position measurement shall be fed back to the controller by a slidewire potentiometer directly coupled to the positioner output shaft. Mounting shall be in any position up to 90 degrees from the normal vertical. Output shaft shall move through a total travel of 85 angular degrees in one minute. The positioner shall provide a scale graduated from 0 to 100 to indicate output shaft position locally. A handwheel for local manual operation of the positioner and field adjustable limit switches shall be provided. The actuator shall contain output capability as to allow total control by the plant's SCADA system as to operate based on the on/off operations of the raw water pumps, vertical turbine pumps or as programmed by the SCADA system.
3. Electric actuators shall be as manufactured by AUMA or an engineer approved equal. Actuators shall be open-close or modulating as indicated on the drawings.

2.12 SURGE RELIEF VALVE (HYDRAULIC)

- A. The surge relief valve shall open quickly at a pre-determined overpressure to dissipate surge and close slowly after restoration of normal pressure. Plus, open quickly at a pre-determined underpressure setting, remain open for a suitable time period to dissipate surge and then slowly close. An adjustable time delay pilot shall be provided for regulating the valve open time during an under-pressure condition.



Needle valves shall be furnished to provide independent and adjustable control of the main valve opening and closing speed. The valve shall be completely piped ready for installation.

- B. The main valve shall operate on the differential piston principle such that the area on the underside of the piston is no less than the pipe area, and the area on the upper surface of the piston is of a greater area than the underside of the piston.

The valve piston shall be guided on its outside diameter by long stroke stationary Vee ports that shall be downstream of the seating surface to minimize the consequences of throttling. The valve Vee ports and not the valve seating surfaces shall do throttling.

The valve shall be capable of operating in any position and shall incorporate only one flanged cover at the valve top from which all internal parts shall be accessible. There shall be no stems, stem guides, or spokes within the waterway. There shall be no springs to assist the valve operation.

- C. The valve body shall be of cast iron ASTM A-126 with flanges conforming to the latest ANSI Standards. The valve shall be extra heavy construction throughout. The valve interior trim shall be bronze B-62 as well as the main valve operation.

The valve seals shall be easily renewable while no diaphragm shall be permitted within the main valve body.

Ail controls and piping shall be of non-corrosive construction.

A visual valve position indicator shall be provided for observing the valve piston position at any time.

- D. The valve shall be as manufactured by GA industries of Mars, Pennsylvania; shall be of the size shown on the drawings; and shall be of their Fig. 6600-D Angle Body Pattern (6-inch) Surge Relief Valve with ANSI B16.1 Class 125 flanges for the installation at the high service pumps. Fig. 6600-U Angle Body Pattern (6-inch) Surge Relief Valve with ANSI B16.1 Class 250 flanges shall be installed at the high service vertical turbine pumps.

## 2.13 VALVE APPURTENANCES

A. Valve Boxes

1. All valves not inside structures shall be equipped with standard cast iron valve boxes with covers John Bouchard and Sons No. 8006 square — meter box, unless otherwise shown on the drawings. The base shall be square. Valve boxes shall be square precast concrete type and installed over the pipe on a sound concrete footing. Valve box covers shall be marked as shown on the drawings or, if not shown, shall be marked "water," or "sewage," as appropriate.
2. Mount each valve box in a concrete pad with bronze disc, giving the particulars of the valve as shown on the drawings. Install the valve box on a firm base at the proper elevation only after the valve has been completely installed, and test before backfilling the excavation. Following the installation of the valve box, carefully backfill the ground, and tamp so that the top surface, after completion, will be no more than two (2) inches above the ground surface or exactly even with paved surfaces. In its final position, the box shall not touch the valve or stem at any point.
3. Unless otherwise shown or noted, pour a two- (2) feet wide by six- (6) inches thick concrete pad around the perimeter of the valve box casting of all valve boxes that are not in paved surfaces.

B. Wall Hydrants: Wall hydrants shall be of the compression type, brass or bronze, nonfreeze, with 3/4 inch union right angled inlet and a 3/4 inch hose thread outlet with vacuum breaker. Install hydrants three (3) feet six (6) inches above the floor at the locations shown on the drawings. A hose rack shall be installed adjacent to the wall hydrant.

C. Yard Hydrants: Yard hydrants shall be nonfreeze for 2.5 feet of bury with a one (1) inch inlet and threaded outlet for hose connection with a vacuum breaker. Each yard hydrant shall have a hose rack conveniently located. Paint yard hydrants after installation.

D. Extension Stems

1. Extension stems shall be provided for all valves in buried locations and in other locations shown on the drawings.
2. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve or from Schedule 80 steel pipe having an internal diameter not smaller than the diameter

of the valve stem. Stem couplings shall be both threaded and keyed to the coupled stems and shall be of approved design and construction. Pipe couplings will not be acceptable.

3. Extension stems for buried valves shall extend to within twelve (12) inches of the surface of the ground. Connect each extension stem to the valve operator. Pin all connections. Each extension stem shall be provided with spacers that will center the stem in a valve box and shall be equipped with a standard AWWA wrench nut as described in Section 19 of AWWA C500, except when handwheels are indicated.
- E. Valve Stem Guides: Stem guides shall be cast iron, bronze bushed, and mounted on cast iron brackets. They shall be adjustable in two (2) directions and shall be spaced at sufficiently close intervals to support the stem adequately. Stem guide spacing shall not exceed ten (10) feet, nor shall the 1/r ratio exceed 200.
- F. Valve Identification Tags and Discs
1. Valve identification tags shall be installed on all exposed valves. The tags shall be 1-1/2 inch diameter, round, 19 gauge thick brass discs with a 3/16-inch diameter top hole. The tags shall have on one face, in vertical block style, etched, and backfilled, a 1/2 inch high valve number, in accordance with the Valve Schedule, placed under 1/4 inch high letters indicating the line content or function in abbreviation. The tags shall be Style 250-BL as manufactured by the Seton Nameplate Corporation, New Haven, Connecticut, or equal. All valve tags shall be fastened to the valve stem with 4 ply Monel wire meter seals.
  2. Buried valves shall be installed with a valve identification disc attached to the surface of the concrete placed around the valve box. A valve extension stem and floor box shall also have a valve identification disc installed on the concrete floor adjacent to the floor box. Valve identification discs shall be two- (2) inches diameter, 1/8 inch thick bronze discs with etched lettering and be attached to the concrete in the manner shown on the standard drawings. The following information shall be etched on the disc:
    - a. Line content or function.
    - b. Valve number as submitted by Contractor for A/E approval.
    - c. Arrow mark indicating the direction of rotation to open, with the word OPEN beside it.

G. Manually and Electronically Operated Floor Stands and Bench Stands

1. Floor stands and bench stands shall be handwheel or crank operated, as shown on the drawings, and shall be provided with a threaded cast bronze lift nut to engage the operating stem. Tapered roller bearings shall be provided above and below a flange or the operating nut to support both opening and closing thrusts. Floor stands and bench stands shall operate the sluice gates and valves under the specified operating head with a pull of not more than 40 pounds on the handwheel (18 inches or 24 inches as required) or the handcrank. Gears, if required, shall be steel with machine cut teeth designed for smooth operation. All components shall be totally enclosed in a cast iron case and cover. Positive mechanical seal shall be provided on the operating nut and the pinion shafts to exclude moisture and dirt and to prevent leakage of lubricant out of the hoist. Lubricating fittings shall be provided for the lubrication of all gears and bearings. Floor stands shall include a cast iron pedestal designed to position the input shaft, handwheel, or handcrank approximately 36 inches above the operating floor. Bench stands shall have a cast iron baseplate for mounting instead of pedestals.
2. Nonrising stem indicating floor stands with handwheel operator for gate valves and sluice gates shall be Clow F-5515, Rodney Hunt S-9420, Mueller A-26426, or equal.
3. Nonrising stem handwheel operated bench stands for valves and sluice gates shall be Rodney Hunt, Mueller A-26427, or equal.

- H. Floor Boxes: Floor boxes shall be bushing type to preserve valve stem alignment. Each floor box shall have a cover similar to the valve box covers specified above. Floor boxes shall be Clow, Mueller, or approved equal.

PART 3. EXECUTION

- 3.1 Install all valves and hydrants in strict accordance with the manufacturer's recommendations.
- 3.2 All valves, hydrants and appurtenances thereto shall be suitable for the use and conditions intended for and by this project. Each manufacturer shall certify that valves provided for incorporation into this project will meet these requirements.

END OF SECTION

### PART 1. GENERAL

- 1.1 Contractor shall be responsible for safely storing materials needed for the work that have been accepted by him until they have been incorporated into the completed project. Keep the interiors of all pipes, fittings, and other accessories free from dirt and foreign matter at all times.
- 1.2 Wherever reaction blocking is necessary, it shall be considered an integral part of the water line work, and no separate payment shall be made for it.
- 1.3 All trenches located within the roadway and shoulders shall contain mineral aggregate backfill. The contractor shall clear and grub, remove trees and properly dispose, remove fencing and reinstall, and replace any damaged mailboxes, shrubs, flowers, trees, fencing etc. which are damaged during construction. This work will be incidental to the project and shall be included within the unit bid price for the water line installation the contractor shall also adhere to the Department of Transportation and County Highway Department bore permit guidelines and requirements when performing the State and County Highway bores and installations.

### PART 2. PRODUCTS

#### 2.1 DUCTILE IRON PIPE AND FITTINGS

- A. Ductile cast iron pipe shall be made of good quality ductile iron that meets the requirements for nodular iron castings of ASTM E8. It shall be plain end ductile iron pipe with push-on, single gasket joints. The design thickness shall be that specified by ANSI/AWWA A21.50/C151 where all pipes shall have a wall thickness of Class 350 or as indicated on the drawings.
- B. Ductile iron pipe shall be centrifugally cast in metal or sand-lined molds and shall conform to the specifications of ANSI A21.51/AWWA C151. It shall be made and tested in accordance with ASTM A339 and shall be subjected to and able to withstand a hydrostatic pressure of 500 psi. The maximum depth of pits shall be half that allowed in the AWWA specifications.

- C. The length of each individual piece of ductile iron pipe shipped must be plainly marked on that piece of pipe.
- D. The push-on, single gasket joints shall be either Fastite (manufactured by American Cast Iron Pipe Company), Tyton (U. S. Pipe and Foundry Company), Super Bell-Tite (Clow Corporation), or other joints of similar type and equal quality. They shall be UL approved and meet the AWWA C110 and C111 requirements. All joints/gaskets shall be able to withstand a minimum of operating pressure that is associated with the Class of pipe specified. For example, gaskets on Class 350 pipe shall be able to withstand a minimum operating pressure of 350 psi.
- E. The bell of each pipe shall have a tapered annular opening and a cast or machined retaining groove for the gasket. The gasket groove shall have a flared design so that maximum deflection will be provided. The plain spigot end of the pipe shall be beveled in order to simplify its entry into and centering within the bell and the compression of the gasket.
- F. The gasket shall be of high quality vulcanized rubber made in the form of a solid ring to exact dimensions. The design of the gasket groove in the bell of the pipe and the design, hardness, and other properties of the gasket itself shall be such that the joint is liquid tight for all pressures from a vacuum to a maximum rating of 350 psi of internal liquid pressure.
- G. Enough lubricant shall be furnished with each order to provide a thin coat on the spigot end of each pipe. This lubricant shall be approved for being in contact with potable water and shall be nontoxic, impart no taste or smell to the water, and have no harmful effect on the rubber gasket. It shall have a consistency that will allow it to be easily applied to the pipe in either hot or cold weather and that will enable it to adhere to either wet or dry pipe. In no case shall lubricant other than that supplied by the pipe manufacturer be used.
- H. Standard and special fittings shall be ductile iron. Use standard mechanical joint fittings. All fittings shall conform to ANSI A21.10/AWWA C110 or ANSI A21.53/AWWA C153.
- I. Pipe and fittings shall be lined with enameled or thin cement lining as specified in ANSI A21.4/AWWA C104. In addition, a bituminous seal coat or asphalt emulsion spray coat approximately 1 mil thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices.

- J. Fittings shall be in accordance with the standard mechanical joint fittings manufactured by the U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal.
- K. The pipe manufacturer is to furnish the A/E a certificate of inspection, sworn to by the factory inspector in the presence of a notary public, stating that the pieces of pipe in the shipment were made and tested in accordance with ANSI A21.51 and that they were subjected to and withstood a hydrostatic pressure of 500 psi. Each statement is to give the number of pieces of pipe in the shipment, the length of each piece of pipe, and the serial number of each piece of pipe making up the shipment. In addition, the weight of each individual piece of pipe making up the shipment is to be listed opposite the serial number of each pipe length and attached to the certificate of inspection.
- L. All fittings, valves, and hydrants shall be restrained using mechanical joint restraints as manufactured by EBBA Iron Megalug or an engineer approved equal.
- M. Concrete thrust blocking shall be required at all ductile iron bends per Standard Detail drawings.

## 2.2 PVC PIPE

- A. All plastic pipe shall be made from Class 12454-B polyvinyl chloride plastic (PVC 1120) as defined by ASTM D1784.
- B. All Class 200,250, or 315 pipe shall have NSF approval and be manufactured in accordance with ASTM D2241. The following tests shall be run for each machine on each size and type of pipe being produced, as specified below:
  - 1. Flattening Test: once per shift in accordance with ASTM D2412. Upon completion of the test, the specimen shall not be split, cracked, or broken.
  - 2. Acetone Test (Extrusion Quality Test): once per shift in accordance with ASTM D2152. There shall be no flaking, peeling, cracking, or visible deterioration on the inside or outside surface after completion of the test.
  - 3. Quick Burst Test: once per 24 hours in accordance with ASTM D1599.

SDR	Pressure Rating	Minimum Bursting Pressure, PSI
13.5	315	1,200



17	250	1,000
21	200	800

4. Impact Tests: for 6 inches and larger, once per shift in accordance with ASTM D2444; for 4 inches and smaller, once each two hours in accordance with ASTM D2444.
  5. Wall Thickness and Outside Dimensions Tests: once per hour in accordance with ASTM D2122.
  6. Bell Dimension Test: once per hour in accordance with ASTM D3139.
- C. If any specimen fails to meet any of the above mentioned tests, all pipe of that size and type manufactured between the test periods must be scrapped and a full set of tests rerun.
- D. Furnish a certificate from the pipe manufacturer stating that he is fully competent to manufacture PVC pipe of uniform texture and strength and in full compliance with these specifications and further stating that he has manufactured such pipe and done so in sufficient quantities to be certain that it will meet all normal field conditions. In addition, the manufacturer's equipment and quality control facilities must be adequate to ensure that each extrusion of pipe is uniform in texture, dimensions, and strength. Also furnish a certificate from the manufacturer certifying that the pipe furnished for this project meets the requirements of these specifications.
- E. All pipe shall be manufactured in the United States of America. The same manufacturer shall make all pipe for any one project.
- F. All 4 inches and 6 inches pipe may be furnished in the manufacturer's standard laying lengths of 20 feet, 38 feet, or 40 feet. Pipe 8 inches and larger shall be furnished in 20 feet lengths. The Contractor's methods of storing and handling the pipe shall be approved by the A/E. All pipe shall be supported within 5 feet of each end; in between the end supports, there shall be additional supports at least every 15 feet. The pipe shall be stored away from heat or direct sunlight. The practice of stringing pipes out along the proposed water line routes will not be allowed.
- G. Certain information shall be applied to each piece of pipe. At the least, this shall consist of:
1. Nominal size
  2. Type of material
  3. SDR or class
  4. Manufacturer
  5. NSF Seal of Approval

- H. Pipe that fails to comply with the requirements set forth in these specifications shall be rejected.
- I. The pipe shall have push-on joints designed with grooves in which continuous molded rubber ring gaskets can be placed. Gaskets shall be made of vulcanized natural or synthetic rubber; no reclaimed rubber will be allowed. Gasket materials shall meet the requirements of ASTM F477. The gaskets shall be of the manufacturer's standard design dimensions and of such size and shape as to provide a positive seal under all combinations of joint and gasket tolerance. The gasket and annular groove shall be designed and shaped so that when the joint is assembled, the gasket will be radially compressed to the pipe and locked in place against displacement, thus forming a positive seal.
- J. The spigot end of each pipe shall be beveled so that it can be easily inserted into the gasket joint, which in turn shall be designed so that the spigot end may move in the socket as the pipe expands or contracts. The spigot end shall be striped to indicate the distance into which it is to be inserted into the socket. Each joint shall be able to accommodate the thermal expansions and contractions experienced with a temperature shift of at least 75 degrees F.
- K. Enough lubricant shall be furnished with each order to provide a coat on the spigot end of each pipe. This lubricant shall approved for being in contact with potable water and shall be nontoxic, impart no taste or smell to the water, have no harmful effect on the gasket or pipe material, and support or promote any bacterial growth. The lubricant containers shall be labeled with the manufacturer's name. In no case shall lubricant other than that supplied by the pipe manufacturer be used.
- L. Joints shall be manufactured in accordance with ASTM D3139 except that the thickness of the bell shall be, as a minimum, equal to that of the barrel. Joints shall be either integral bell and ring joints with rubber compression gaskets as manufactured by the Clow Corporation, Johns-Manville, or Vulcan Plastic Corporation; twin gasket couplings as manufactured by the Certain-Teed Products Corporation; or equal. However, the same manufacturer must make the pipe and bell.
- M. Standard and special fittings shall be gray iron or ductile iron. Use standard mechanical joint fittings. All fittings shall conform to the specifications of ANSI A21.10/AWWA C110. The gaskets shall be ducked tipped transition gaskets for use with PVC pipe.
- N. Fittings shall be lined with enameline or a thin cement lining as specified in ANSI A21.4/AWWA C104. In addition, a bituminous seal coat or asphalt emulsion spray coat approximately 1 mil thick shall be applied to the cement lining in accordance with the pipe manufacturer's standard practices.

- O. Fitting laying lengths shall conform to ANSI A21.10/AWWA C110.
- P. Fittings shall be in accordance with the standard mechanical joint fittings manufactured by the U.S. Pipe and Foundry Company, American Cast Iron Pipe Company, Clow Corporation, or equal.

### PART 3. EXECUTION

#### 3.1 INSTALLATION OF WATER LINES

- A. Lay water lines to and maintain at the lines and grades required by the drawings. All fittings, valves, and hydrants shall be at the required locations, the spigots centered in the bells, and all valves and hydrant stems plumb.
- B. Unless otherwise indicated by the drawings, all water pipes shall have at least 30 inches of cover. No departure from this policy shall be made except with the approval of the A/E.
- C. Provide and use tools and facilities that are satisfactory to the A/E and that will allow the work to be done in a safe and convenient manner. All pipe, fittings, valves, and hydrants are to be unloaded from the trucks using suitable tools and equipment. Use a derrick, ropes, or other suitable tools or equipment to lower all pipe, fittings, valves, and hydrants into the trench one piece at a time. Lower each piece carefully so that neither it nor any protective coating or lining it may have will be damaged. Under no circumstances drop or dump water line materials into the trench.
- D. Any pipes strung out along the route of the proposed lines before the actual installation of those lines is due to take place shall not be lowered into the trench until they have been swabbed to remove any mud, debris, etc., that may have accumulated within them. PVC pipe shall be strung out a maximum of one day ahead of pipe laying. Remove all unnecessary material from the bell and spigot end of each pipe. Before any pipe is laid, brush and wipe clean the outside of its spigot end and the inside of its bell, and leave dry and oil-free.
- E. Take every precaution to keep foreign material from getting into the pipe while it is being placed in the line. If the crew laying the pipe cannot put it into the trench and in place without allowing earth to get inside, then put a heavy, tightly woven canvas bag of suitable size over each end of the pipe, and leave in place until it is time to connect that pipe to the one adjacent to it.

- F. Place no debris, tools, clothing, or other materials in the pipe during laying operations.
- G. After a length of pipe has been placed in the trench, center the spigot end in the bell of the adjacent pipe, and then insert to the depth specified by the manufacturer and bring to the correct line and grade. Secure the pipe in place by tamping an approved backfill material around it.
- H. Bell holes shall be big enough so that there is ample room for the pipe joints to be properly made. Between bell holes, carefully grade the bottom of the trench so that each pipe barrel will rest on a solid foundation for its entire length.
- I. Whenever pipe laying is not in progress, close the open ends of pipe either with a watertight plug or by other means approved by the A/E. If the joints of any pipe in the trench cannot be completed until a later time, caulk them with packing in order to make them as watertight as possible; this shall be done not only at the end of each working day but also before work is stopped for lunch periods, bad weather, or any other reason. If there is water in a trench, leave this seal in place until the trench has been pumped completely dry.
- J. Cut pipe so that valves, fittings, or closure pieces can be inserted in a neat and workmanlike manner and without any damage to the pipe. Follow the manufacturer's recommendations concerning how to cut and machine the ends of the pipe in order to leave a smooth end at right angles to the pipe's axis.
- K. Lay pipe with the bell ends facing in the direction of laying unless otherwise directed by the A/E.
- L. Wherever pipe must be deflected from a straight line (in either the vertical or horizontal plane) in order to avoid obstructions or plumb stems, or wherever long radius curves are permitted, the amount of deflection shall not exceed that necessary for the joint to be satisfactorily made, nor that recommended by the pipe manufacturer, and shall be approved by the A/E.
- M. Lay no pipe in water or when it is the A/E's opinion that trench conditions are unsuitable. If crushed stone is used to improve trench conditions or as backfill for bedding the pipe, its use is considered incidental to the project, and no separate payment will be made for its use.

- N. Where a water line crosses over a sanitary sewer, use a full joint of pipe with a standard mechanical joint, and center over the sewer. Where a water line is to be parallel to a sanitary or storm sewer, lay it at least 10 feet from the sewer. If it is not practical for the water and sewer lines to be separated as described above, then lay the water line at least 18 inches above the top of the sewer.
- O. Joint all pipe in the exact manner specified by the manufacturer of the pipe and jointing materials.
- P. For detection purposes, a 14-gage solid strand copper tracing wire (shielded) shall be installed as per the manufacturer's instructions. Connections between wires shall be soldered or connected with wire nut fasteners and wrapped.

### 3.2 HYDROSTATIC TESTS

#### A. Pressure Test

1. After pipe has been laid and backfilled as specified above, subject all newly laid pipe or any valved section thereof to a pressure of 200 psi. All services are to be laid prior to testing the main and tested as part of the test of the main.
2. The duration of each pressure test shall be at least one hour.
3. Slowly fill each valved section of pipe with water, and apply the specified test pressure (based on the elevation of the lowest point of the line or section under test and corrected to the elevation of the test gauge) with a pump connected to the pipe in a manner satisfactory to the A/E. Furnish the pump, pipe, connections, gauges, and all necessary apparatus.
4. Before applying the specified test pressure, expel all air from the pipe. If hydrants or blowoffs are not available at high places, make the necessary taps at the points of highest elevation before testing, and insert plugs after the test has been completed.
5. Carefully examine all exposed pipes, fittings, valves, and hydrants during the test. Remove any cracked or defective pipes, fittings, valves, or hydrants discovered in consequence of this pressure test, and replace with sound material in the manner specified. Repeat the test until the results are satisfactory to the A/E.

#### B. Leakage Test

1. Conduct the leakage test after the pressure test has been satisfactorily completed. Furnish the pump, pipe, connections, gauges, measuring devices, and all other necessary apparatus as well as all necessary assistance to conduct the test.
2. The duration of each leakage test shall be two hours; during the test, subject the main to a pressure of 200 psi.
3. Leakage is defined as the amount of water which must be supplied to the newly laid pipe or any valved section in order to maintain the specified leakage test pressure after the pipe has been filled with water and the air expelled.
4. No pipe installation will be accepted until the leakage is less than the number of gallons per two-hour period listed below:

Pipe Sizes	Gallons per 1,000 Feet of Pipe
2 inches - 2-1/4 inches	0.2
3 inches	0.5
4 inches	0.6
6 inches	0.9
8 inches	1.2
Pipe Sizes	Gallons per 1,000 Feet of Pipe
10 inches	1.5
12 inches	1.9
14 inches	2.2
16 inches	2.6
18 inches	2.9
20 inches	3.2
24 inches	3.8

In addition, the maximum allowable leakage shall not exceed 10 gallons per inch of pipe diameter per mile of pipe per 24 hours when tested at 1- 1/2 times the working pressure or rated pressure of the pipe, whichever is greater.

5. Should any test of pipe laid disclosure leakage greater than specified, the Contractor shall, at his own expense, locate and repair the defective joints until the leakage is within the specified allowance.

### 3.3 DISINFECTION

- A. During construction, take precautions to protect pipe interiors, fittings, and valves against contamination. When pipe laying is not in progress (e.g., at the end of the day's work), place watertight plugs in the ends of all pipe already in the trench; if water accumulates in the trench, leave the plugs in place until the trench is dry. Complete the joints of all pipe in the trench before stopping work for any reason.
- B. If dirt or other foreign material that has gotten into a pipe will not, in the opinion of the A/E, be removed by flushing, clean the interior of the pipe, and swab with a disinfecting solution of 5% hypochlorite.
- C. Make water flow from the existing distribution system or some other source approved by the A/E into the newly laid pipeline, and add chlorine to it. Feed water into the pipe, and chlorine into the water, at constant, measured rates so proportioned that the chlorine concentration in the water in the pipe is kept at a minimum of 50-mg/l available chlorine. To ensure that this concentration is maintained, measure the chlorine residual at regular intervals.
- D. Table I shows how much chlorine is needed for each 100 feet of line for pipes of various diameters. A 1% chlorine solution may be prepared either with 1 pound of calcium hypochlorite for each 8.5 gallons of water or with sodium hypochlorite.

TABLE I

CHLORINE REQUIRED TO PRODUCE A 50 MG/L CONCENTRATION  
IN 100 FEET OF PIPE, BY DIAMETER

Pipe Size (inches)	100% Chlorine (Pounds)	1% Chlorine Solutions (Gallons)
4	0.027	0.33
6	0.061	0.73
8	0.108	1.30
10	0.170	2.04
12	0.240	2.88
14	0.328	3.96
16	0.428	5.12
18	0.540	6.48
20	0.680	8.00
24	0.980	11.52

- E. While the chlorine is being applied, manipulate valves so that the treatment

dosage will not flow back into the line that is supplying the water. Continue the application of chlorine until the entire line being treated is filled with the chlorine solution. Then retain the chlorinated water in the line for at least 24 hours, during which time all valves and hydrants in the line being treated shall be operated so that appurtenances can also be disinfected. After 24 hours, the treated water shall have a chlorine concentration of at least 25 mg/l throughout the line.

- F. After the applicable retention period, flush the heavily chlorinated water from the line until the chlorine concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/l. Perform such flushing only at sites where there is adequate drainage.
- G. The velocity of the water used to flush a line shall be at least 2.5 fps. The flow rates required to produce this velocity in various sizes of pipe are shown in Table II.

TABLE II

REQUIRED OPENINGS TO FLUSH PIPELINES  
(40 PSI RESIDUAL PRESSURE)

Pipe Size (Inches)	Flow Required To Produce 2.5 fps Velocity (g pm)	Orifice Size (Inches)	Hydrant Outlet Nozzles Size Number (Inches)	
4	100	15/16	1	2-1/2
6	220	1-3/8	1	2-1/2
8	390	1-7/8	1	2-1/2
10	610	2-5/16	1	2-1/2
12	880	2-13/16	1	2-1/2
14	1,200	3-1/4	2	2-1/2
16	1,565	3-5/8	2	2-1/2
18	1,980	4-3/16	2	2-1/2
20	2,440	-----	2	2-1/2
24	3,470		2	2-1/2

- H. Once a line has been flushed, test to make certain that the residual chlorine in the water is within acceptable limits.
- I. It must be noted that flushing is no substitute for taking preventative measures before and during the laying of water lines. Certain contaminants (especially those in caked deposits) are difficult or even impossible to remove by flushing, no matter how high the velocity. Further-more, in pipes with diameters of 16 inches or more, it can be difficult to achieve even the minimum recommended flushing velocity of 2.5 fps.



### 3.4 BACTERIOLOGICAL TESTS

- A. After a water line has undergone final flushing but before it is placed into service, collect a sample for bacteria-logical testing from the end of that line. In the case of extremely long lines, take additional samples if the A/E so directs.
- B. Collect these samples in sterile bottles treated with sodium thiosulfate. Do not use a hose or fire hydrant to collect samples. One suggested sampling method is to install a standard corporation cock in the line with a copper tube gooseneck assembly; after the samples have been taken, the gooseneck assembly can be removed and retained for later use.
- C. Take the samples collected to an approved laboratory to be tested for bacteriological quality in order to determine if they contain any coliform organisms. If the initial disinfection fails to produce satisfactory samples, repeat disinfection until satisfactory samples are obtained.
- D. When the samples tested are found to be satisfactory, the water line may be placed in service.

### 3.5 DISINFECTION PROCEDURE AFTER CUTTING INTO OR REPAIRING EXISTING LINES

- A. The procedures outlined above apply primarily to cases in which the lines are wholly or partially dewatered.
- B. However, leaks or breaks that are repaired with clamping devices while the lines remain full of water under pressure present little danger of contamination and require no disinfection.
- C. When an existing line is opened, whether by accident or design, the excavated area could be wet and contaminated because of the presence of sewers nearby. The danger of contamination from such pollution can be lessened if liberal quantities of hypochlorite are applied to the open trenches. It is better to use tablets for disinfection in such cases because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation site.

- D. Where practical, treat the lines by the slug method In accordance with ANSI/AWWA C651.
- E. The following disinfection procedure is considered the minimum that may be used when existing lines are repaired:
  - 1. Swab the interior of all pipes and fittings (particularly couplings and tapping sleeves) that are to be used in repairing an existing line with a solution of 5% hypochlorite before installing them.
  - 2. The most practical means of removing contamination introduced into a line during repairs is to give the line a thorough flushing. If the locations of valves and hydrants make it possible, flushing in both directions is recommended. Start flushing as soon as repairs are completed, and continue until all discolored water is eliminated.

### 3.6 CLEANUP

- A. After completing each section of water line, remove all debris and all construction materials from the work site. Then grade arid smooth over the surface of both sides of the line. Leave the entire area clean and in a condition satisfactory to the A/E.

END OF SECTION

## PART 1. GENERAL

- 1.1 All plant and yard piping, including drain sewers, shall be ductile iron pipe unless noted otherwise on the Plans.
- 1.2 Shop drawings are required for all products specified in this section.
- 1.3 Refer to other sections for items affecting gravity sewers. Coordinate this work with that specified by others sections for timely execution.

## PART 2. PRODUCTS

### 2.1 PIPE

- A. Reinforced Concrete: pipe to be of reinforced concrete pipe conforming to the requirements of ASTM C76, Class IV, with Wall Thickness B, unless otherwise authorized by the A/E in writing, and as specified on the drawings; circular concrete pipe with elliptical reinforcements will not be acceptable.
- B. Laying lengths of reinforced concrete sewer pipe shall not exceed eight (8) feet unless written approval of the A/E is secured. Pipe shall be manufactured with machine bell pallets with a maximum slope of two (2) degrees.
- C. Polyvinyl Chloride (PVC): to meet and/or exceed the requirements of ASTM D3034, SDR 35; suitable for use as a gravity sewer Conduit with provisions for contraction and expansion at each joint; with a rubber ring and standard length 12.5 feet plus or minus one (1) inch; designed to pass all tests at 73 degrees F (plus or minus 3 degrees F); six (6) inches long sections of pipe to be subjected to impact from a free falling type (20 pounds, Type A) in accordance with ASTM D2444 with no evident splitting or shattering (denting not considered a failure); and with a minimum envelope of four (4) inches of granular material around the pipe, but with all other bedding and backfilling requirements remaining the same as for other pipe material.
- D. Ductile Iron: with push-on joints conforming to ASTM X746, Class 50 thickness unless otherwise shown on the drawings.
- E. Lateral Branches: to be tees of the same material as the main sewer and

have a six (6) inches inside diameter unless otherwise specified or noted; able to withstand all test pressures involved without leakage.

## 2.2 JOINTS AND JOINTING MATERIALS

- A. Concrete Pipe Joints: Joints shall be compressive type in accordance with ASTM C361, Type R-4 (bell and spigot) with resilient seals embedded in both the bell and spigot ends. They shall be joints with O-ring gaskets.
- B. All rubber end rings shall be extruded or molded and cured such that any cross section will be dense, homogenous and free of parasites, blisters, pitting, and other imperfections. The basic rubber material, EPDM, shall meet ASTM C443 with the exception of 40-60 duro hardness. The resilient interlocked end seals shall be duro A-40-70, plus or minus 2.
- C. Polyvinyl Chloride (PVC) Pipe Joints: Joints for sewer plastic pipe shall meet all requirements of ASTM D3212 standard specifications. Joint design shall be tested and certified to result in no leakage under prescribed laboratory test conditions of joint alignment, load conditions, pressure and vacuum, and deflection. Pipe and fittings shall have integral bell with elastomeric seal joint.
- D. Ductile Iron Pipe Joints: gasket type joints for bell and spigot ductile iron pipe designed to meet the infiltration requirements of these specifications; jointing to comply with the applicable provisions of ANSI A21.11.

## 2.3 COMPRESSION COUPLINGS

- A. When dissimilar pipe materials like PVC and concrete pipe are joined, use compression couplings that are resistant to the corrosive action of soils and sewage and that will provide a permanent watertight joint. The compression couplings shall be of natural or synthetic rubber or rubber-like material and shall comply with the requirements and test methods specified in Table 2 of ASTM C425. The coupling shall meet the leak requirements specified in ASTM C425, and the bands for attaching the couplings to the dissimilar pipes shall be of stainless steel meeting ASTM A167 or A240. Each coupling shall bear the manufacturer's identifying mark and an indication of its size.

## PART 3. EXECUTION

### 3.1 PIPE LAYING

- A. Lay no pipe except in the presence of an inspector representing the A/E.

- B. Before placing sewer pipe in position in the trench, carefully prepare the bottom and sides of the trench, and install any necessary bracing and sheeting as provided in Section 02221, Unclassified Excavation for Utilities.
- C. Wherever necessary to provide satisfactory bearing surface, place concrete cradles as shown on the drawings or as directed by the A/E. Cradles shall be of concrete and conform to the dimensions shown on the drawings. Concrete placed outside the dimensions shown shall be at the Contractor's expense.
- D. Tightly stretch a mason's line or wire above ground level, parallel to and directly above the axis of the pipe to be installed, supporting this line at intervals of no more than 50 feet for sewers being laid on a grade of 2% or more and of no more than 25 feet for grades of less than 2%. Determine the exact line and grade for each section of pipe by measuring down from this line to the invert of the pipe in place, and accurately place each pipe to the exact line and grade called for on the drawings. Furnish all labor and materials necessary for erecting batterboards.
- E. Lasers may be used after the type and procedures are approved by the A/E. When lasers are used, set reference points for both line and grade at each manhole. Where grades are 0.6% or less, check the elevation of the beam each 100 feet with an offset point or engineer's level.
- F. Do not allow water to run or stand in the trench while pipe laying is in progress or before the trench has been backfilled. Do not at any time open up more trench than the available pumping facilities are able to dewater.
- G. Correct trench bottoms found to be unsuitable for foundations after pipe laying operations have started, bringing them to exact line and grade with compacted earth as necessary.
- H. Carefully inspect each piece of pipe and special fitting before it is placed, and lay no defective pipe in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, keep the ends of the pipe tightly closed with an approved temporary plug.
- I. Bell holes shall be large enough to allow ample room for the pipe joints to be properly made. Cut out bell holes no more than two (2) joints ahead of the pipe laying. Carefully grade the bottom of the trench between bell holes so that each pipe barrel rests on a solid foundation for its entire length. Lay each pipe joint so as to form a close concentric joint with adjoining pipe and to avoid sudden offsets or inequalities in the flow line.

- J. Before constructing or placing any joints, demonstrate to the A/E, by completing at least one sample joint, that the methods to be used conform to the specifications and will provide a watertight joint and further that the workmen to be involved in this phase of work are thoroughly familiar and experienced with the type of joint proposed.
- K. No other type of joint may be used unless authorized in writing by the A/E.
- L. Install tee branches in sewer lines to serve properly each lot facing or abutting on the street or alley in which sewer is being laid and at such other locations as may be designated by the A/E. If tee branches are not to be used immediately, close them with approved stoppers that are held in place to prevent infiltration and withstand all test requirements.
- M. For all tees that are plugged and laid in rock, blast a minimum of six (6) linear feet of ditch line in the direction and to the approximate grade of the future lateral as directed by the A/E, but do not excavate the material. This shall be done at no extra cost to the Owner. Furnish the A/E with a record of the exact location of each tee installed.
- N. If the work consists of constructing a new sewer to replace an existing one, connect existing service lines to the new line.
- O. New service laterals shall conform to the standard drawings.
- P. As the work progresses, thoroughly clean the interior of the pipe in place. After each line of pipe has been laid, carefully inspect it, and remove all earth, trash, rags, and other foreign matter from its interior.
- Q. After the joints have been completed, they shall be inspected, tested, and accepted by the A/E before being covered. The pipe shall meet the test requirements for watertightness; immediately repair any leak or defect discovered at any time after completion of the work. Any pipe that has been disturbed after joints were formed shall be taken up, the joints cleaned and remade, and the pipe relaid at the Contractor's expense. Carefully protect all pipe in place from damage until backfilling operations are completed.
- R. Do not begin the backfilling of trenches until the pipe in place has been inspected and approved by the A/E.
- S. Lay sewers at least ten (10) feet horizontally from any existing or proposed wafer main. If this is not practical, the sewer may be laid closer than ten (10) feet to a water main provided it is laid in a separate trench and the elevation of the top of the sewer is at least 18 inches below the bottom of the water main.

- T. Where a sewer crosses under water mains, the top of the sewer shall be at least 18 inches below the bottom of the water main. If the elevation of the sewer cannot be varied to meet the above requirements, relocate the water main to provide this separation, or else reconstruct it with mechanical joint ductile iron pipe for a distance often (10) feet on each side of the sewer with a full joint of the water main centered over the sewer.
- U. If it is impossible to obtain proper horizontal and vertical separation as stipulated above, construct both the water main and the sewer of mechanical joint ductile iron pipe, and pressure test each.
- V. Perform boring by means of auguring to the size, line, and grade shown on the drawings. Jack the steel casing pipe into place as the boring proceeds. Weld sections of casing pipe together to provide a watertight joint.
- W. Make connections to all existing sewer lines as shown on the drawings or as directed by the A/E. Make connections either by removing a section of the sewer from the existing line and inserting a wye or tee branch of the proper size or by constructing a manhole, junction box, regulator chamber, or other structure as shown on the drawings.
- X. Make connections to existing manholes or inlets by cutting a hole in the wall of the existing structure, inserting a length of sewer pipe with PVC gasketed sleeve into the hole, filling around the pipe with concrete or mortar, and troweling the inside and outside surfaces of the joint to a neat finish. Shape or reshape the bottom of the manholes as necessary to fit the invert of the sewer pipe.
- Y. Joint dissimilar pipe by using suitable compression couplings. If compression couplings are not available, make jointing with a special fabricated coupling approved by the A/E.
- Z. Provide concrete protection or concrete cap as shown on the drawings for pipe sewers that, when completed, have less than 2.5 feet of covering in nontraffic areas and four (4) feet of cover in traffic areas. If such protection is not shown on the drawings, place it in accordance with the typical section shown.
- AA. Carefully protect from damage all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electrical lines, and other utilities or structures in the vicinity of the work at all times. If it is necessary to repair, remove, and/or replace any such utility or structure in order to complete the work properly, do so in compliance with the provisions set forth in other section of these specifications. Any such work shall be considered incidental to the construction of pipe sewers, and no additional payment will be allowed therefore.

- BB. Water service connections will be repaired or replaced by the Contractor at his expense as an incidental part of the work.
- CC. Service or house connections to existing sewers that are damaged or removed shall be repaired or replaced by the Contractor at his own expense as an incidental part of the work.
- DD. All testing of concrete pipe and materials will be made by a commercial testing laboratory. Before beginning work, furnish the A/E with the name of the pipe materials supplier. No pipe shall be delivered to the job site which does not bear the testing laboratory's stenciled or other marked sign of acceptance. Furnish the A/E with 2 certified copies of the testing laboratory's report of inspection, testing, and acceptance on all pipe and specials.
- EE. For PVC and ductile iron pipe, furnish a certificate from the pipe manufacturer indicating that the pipe meets all applicable requirements of these specifications.
- FF. Reinforced concrete pipe shall be tested by and meet the requirements of the Permeability Test and Hydrostatic Test of ASTM C14.
- GG. The minimum pipe stiffness for PVC pipe at 5% deflection shall be 46 for all sizes when tested in accordance with ASTM D2412; external loading properties of plastic pipe shall be by parallel plate loading.
- HH. A specimen of PVC pipe six (6) inches long shall be flattened between parallel plates in a suitable press until the distance between the plates is 40% of the outside diameter of the pipe. The rate of loading shall be uniform and such that the compression is complete in two (2) to five (5) minutes.
- II. After being immersed for two (2) hours in a sealed container of anhydrous acetone (99.5% pure), a sample ring of PVC pipe shall show no visible spalling or cracking when tested in accordance with ASTM D2152 (swelling or softening is not considered a failure).

### 3.2 TESTING OF GRAVITY SEWERS

#### A. Visual Tests

1. Upon completion of the construction or earlier if the A/E deems advisable, the A/E will make a visual inspection of the sewer and construction site. Immediately repair all leaks and defects found by such inspection.
2. In addition to general cleanup and leakage, the following standards shall be used to determine failure or defects of this project.
3. Sewers shall be built so as to remain true to line and grade. The



inclining grade of the bottom of the sewer after completion shall be such that, after flooding, the flood water drains off so that no remaining puddle of water is deeper than 1/2 inch on pipe 36 inches internal diameter or smaller and 3/4 inch on pipe larger than 36 inches internal diameter. Any section of pipe that does not comply with the specifications at any time previous to final acceptance of the work shall be replaced or relaid at the Contractor's expense.

4. The Contractor will be held strictly responsible that all parts of the work bear the load of the backfill. If cracks 1/100 inch develop in the pipe within one (1) year from the date of final acceptance of the work, the Contractor will be required to replace, at his expense, all such cracked pipe. To this end, the Contractor is advised to purchase pipe under a guarantee from the manufacturer, guaranteeing proper service of sewer pipe under conditions established by the drawings, specifications, and local conditioning at the site of the work.

B. Air Testing for Sewers 24 Inches and Smaller

1. Perform low pressure air testing as follows:
  - a. Furnish all equipment, facilities, and personnel necessary to conduct the test. The test shall be observed by a representative of the A/E.
  - b. Make the air test after all services have been installed and backfilling has been completed and compacted.
  - c. Perform the first series of air tests after 2,000 linear feet but before 4,000 linear feet of sewer has been laid. The purpose of this first series of tests is to assure both the Contractor and the A/E that the materials and methods of installation meet the intent of these specifications. Conduct the remainder of the tests after approximately each 10,000 linear feet has been laid.
  - d. Plug all tees and ends of sewer services with flexible joint plugs or caps securely fastened to withstand the internal test pressures. Such plugs or caps shall be readily removable, and their removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.
  - e. Prior to testing, check the pipe to see that it is clean. If not, clean it by passing a full-gauge squeegee through the pipe. It shall be the Contractor's responsibility to have the pipe cleaned.

- f. Immediately following this check or cleaning, test the pipe installation with low pressure air. Supply the air slowly to the plugged pipe installation until the internal air pressure reaches 4.0 psi more than the average back pressure of any ground water that may submerge the pipe. Allow at least two (2) minutes for temperature stabilization.
- g. The pipeline shall be considered acceptable when tested at an average pressure of 3.0 psi more than the average back pressure of any ground water that may submerge the pipe, if the section under test does not lose air at a rate greater than 0.0015 cfm per square foot of internal pipe surface area. Calculate the pressure drop as the number of seconds for the air pressure to drop from a stabilized pressure of 3.5 to 2.5 psi more than the average back pressure of any ground water that may submerge the pipe. Calculate time as described in ASTM C828.
- h. The requirements of this specification shall be considered satisfied if the time required in seconds for the pressure to decrease from 3.5 to 2.5 psi more than the average back pressure of any ground water that may submerge the pipe is not less than that shown in the following table:

ALLOWABLE AIR LOSS VALUES PER 100 LF

Pipe Size	Time In Seconds
6 inches	42
8 inches	72
10 inches	90
12 inches	108
15 inches	126
18 inches	144
21 inches	180
24 inches	216

- i. If the pipe installation fails to meet these requirements, the Contractor shall determine at his own expense the source or sources of leakage and repair or replace all defective materials or workmanship. The completed pipe installation shall meet the requirements of this test before being considered acceptable.

2. The recommended procedures for conducting acceptance tests are as follows:

- a. Clean pipe that is to be tested.
- b. Plug all pipe outlets with suitable test plugs; and brace each plug securely.
- c. Increase gauge pressure in the test by the amount of ground water pressure at the crown of the pipe.
- d. Add air slowly to the portion of the pipe installation being tested until the internal air pressure is raised to 4.0 psi more than the average back pressure above the crown of the pipe.
- e. After the above internal pressure is obtained, allow at least two (2) minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
- f. After two (2) minutes, disconnect the air supply.
- g. When pressure decreases to 3.5 psig either by leaking down or by bleeding down with a release valve, start the stopwatch, and determine the time in seconds that is required for the internal air pressure to reach 2.5 psig.

Compare this time interval as calculated above. If the time is more than that calculated, the test shall be assumed to be acceptable

3. Plugs used to dose the sewer pipe for the air test must be securely braced to prevent the unintentional release of a plug, which can become a high velocity projectile. Locate gauges, air piping manifolds, and valves at the top of the ground. No one shall be permitted to enter a manhole where a plugged pipe is under pressure. Four pounds air pressure (gauge) develops a force against the plug in a 12 inch pipe of approximately 450 pounds. Pipes more than 30 inches in diameter shall not be air tested because of the difficulty of adequately blocking the plugs. Provide a safety release device set to release at ten (10) psi between the air supply and the sewer under test.

4. Regardless of the outcome of the tests, repair any noticeable leak.

C. Testing for Sewers Larger than 24 Inches

1. Using Existing High Ground Water

- a. Where the natural ground water is 24 inches or more above the top of a section of pipe, measure the flow of water in the pipe and the rates of seepage and infiltration. Measure the flow rate by using a calibrated weir. Leave the weir in the line until the flow rate has stabilized. The Contractor is responsible for verifying the ground water level by providing sight gauges in manholes or digging test holes at suitable locations.
- b. The total seepage and infiltration of ground water as determined by the test shall in no case exceed 25 gallons per 24 hours per inch-mile of pipe. Make infiltration tests on all sewer construction before placing the lines in service and before making any connections to other sewers. If the amount of infiltration into the sewer(s) is in excess of the maximum quantity specified above, then recaulk or remake the joints, relay the sewer (if necessary), or perform other remedial construction, at the Contractor's expense, in order to reduce ground water infiltration to within the specified limits.
- c. In making infiltration tests, furnish the required equipment and labor and do the necessary pumping under the direction of the A/E. Tests must be repeated until each sewer individually meets the specifications for infiltration amounts as set out above.

2. Exfiltration Test

- a. Where the ground water is not 24 inches or more above the top of the pipe section being tested, then perform an exfiltration test. Bulkhead the pipe below the lower manhole of the section being tested with a pneumatic plug or other device. Insert a vent pipe 48 inches long in the stopper of the upper end of that section. Then fill the lower manhole with water, or add water until there is a minimum of four (4) feet over the upper end; make certain that all air is forced out through the vent tube. Measure the drop in the level of the water in the manhole due to exfiltration over a specific time, and calculate the water loss due to exfiltration. The total exfiltration shall not exceed that specified above for infiltration. Conditions encountered in construction may vary this procedure slightly, but essentially this is the method to be used.

### 3. Repairs

- a. Regardless of the outcome of any tests, repair any noticeable leak.

### 3.3 VISUAL INSPECTION OF MISCELLANEOUS MATERIALS

- A. All material used on this project will be visually inspected by the A/E at the site for conformance to the required specifications. When reasonable doubt exists that said material meets the specifications, the A/E may require certified mill tests, samples, and/or tests by an independent laboratory or other suitable form of verification that the material meets the required specifications.

### 3.4 DEFLECTION TESTING FOR PVC PIPE

- A. Test deflection of the pipe by passing a 9-arm pin go/no-go mandrel sized to 95% of the pipe diameter of the actual pipe used with the pipe in place and covered. Make this acceptance test after backfill consolidation has occurred.

### 3.5 CLEANUP

- A. After completing each section of the sewer line, remove all debris, construction materials, and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire area in a clean, neat, and serviceable condition.

END OF SECTION

**Finished Water Transmission Lines**  
**Boring and Casing for Sanitary Sewers and Water Lines**

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**PART 1. GENERAL**

- 1.1 The work to be performed hereunder shall consist of the installation of a casing pipe for the purpose of installing a sanitary sewer or water line as shown on the drawings or as called for in these specifications. It shall include the excavation of a boring pit, auger boring between the points as specified on the drawings, furnishing and installing of the carrier pipe, and disposing of the excavated materials in the manner herein provided.

**PART 2. PRODUCTS**

**2.1 CASING PIPE**

- A. The casing pipe shall be of steel meeting the latest approved American Railway Engineering Association "Specifications" for Pipelines for Carrying Flammable and Nonflammable Substances." The steel casing pipe shall have a minimum yield strength of 35,000 PSI and shall have the minimum wall thickness shown in the following table:

TABLE OF MINIMUM WALL THICKNESS FOR STEEL CASING PIPE  
FOR E72 LOADING

<u>Carrier Pipe Diameter</u>	<u>Casing Pipe Diameter</u>	<u>Nominal Thickness</u>
4.inches	8.inches	0.250 inches
6.inches	12.inches	0.250 inches
8.inches	16.inches	0.312 inches
10 inches	20 inches	0.312 inches
12 inches	22 inches	0.312 inches
14 inches	24 inches	0.344 inches
16 inches	26 inches	0.375 inches
18 inches	28 inches	0.406 inches

- B. When the casing pipe is installed without benefit of a protective coating, the wall thickness shown above shall be increased to the nearest standard size, which is a minimum of 0.063 inches greater than the thickness shown.
- 2.2 CARRIER PIPE: The earner pipe shall be Class 200 PVC, unless otherwise noted on the drawings.

## PART 3. EXECUTION

### 3.1 BORING

- A. The boring shall be accomplished by means of auguring to the size, line, and grade shown on the drawings.

### 3.2 INSTALLATION OF CASING PIPE

- A. For boring casing pipes, jack the steel casing pipe into place as the boring proceeds. Weld sections of casing pipe together to provide watertight joints.
- B. For open cut of casing pipes, install the steel casing pipe into the open cut as the trench excavation proceeds. Weld sections of casing pipe together to provide watertight joints, and replace the protective coatings in areas where it is damaged by welding
- C. Do not remove unacceptable casing without prior approval from the A/E. If the removal of casing pipe is permitted, make proper provisions to prevent caving in of the earth surrounding the casing.

### 3.3 INSTALLATION OF CARRIER PIPE

- A. The carrier pipe shall be furnished by the Contractor. Upon acceptance of the casing, install the carrier pipe in the casing by jacking it through the casing. If necessary to achieve proper line and grade on the carrier pipe, strap wood or other suitable blocking to the earner pipe to offset any minor variations in the alignment of the casing.

### 3.4 LAYOUT OF WORK

- A. The Owner will provide the necessary control points required by the Contractor for this construction. The Contractor will provide the detailed layout required to keep the tunnel or bore on grade.

## 4 GUARANTEE OF WORK

- 4.1 Guarantee a usable completed casing between the points specified and to the line and grade specified. The allowable tolerance at the downstream end point of the bore shall be such that the invert of the earner pipe may be positioned within a vertical area limited on the top by an elevation no higher than the elevation shown on the drawings and on the bottom by an elevation no lower than the existing inlet pipe invert. For sewers, the sides shall be a minimum of 8 inches inside the interior face of the manhole at the end of the bore.
- 4.2 The allowable tolerance at the upstream end point of the bore shall be such that the invert of the carrier pipe may be positioned at the elevation shown on the drawings.

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

- A. All formwork for cast-in-place concrete, complete with shoring, bracing and anchorage.
- B. Form openings for mechanical and electrical work.
- C. Coordinate installation of items supplied by other sections of work.
- D. Pre-formed construction joints.
- E. Dovetail anchor joints.
- F. Flashing reglets.

**1.2 RELATED REQUIREMENTS**

- A. Section 03200: Concrete Reinforcing.
- B. Section 03300: Cast-In-Place Concrete.
- C. Section 04200: Masonry.
- D. Section 05500: Metal Fabrications.
- E. Division 15: Mechanical items to be imbedded in concrete.
- F. Division 16: Electrical items to be imbedded in concrete.

**1.3 QUALITY ASSURANCE**

- A. Construct and erect concrete framework in accordance with ACI 347 and applicable construction safety regulations for place of work,



#### 1.4 REFERENCES

- A. The following references shall be obtained by the General Contractor and maintained at the job site:

1. ACI 301 - Specifications for Structural Concrete for Buildings.
2. ACI 347 - Recommended Practice for Concrete Formwork.

#### 1.5 ALLOWABLE TOLERANCES

- A. In accordance with ACI 301 as listed in table 4.3.1 - Tolerances for Formed Surfaces.

#### 1.6 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300.

### PART 2. PRODUCTS

#### 2.1 FORM MATERIALS

1. Plywood: B-B Plyform, class I or II, Ext-APA; sound undamaged sheets with clean true edges.
2. Lumber: No. 2 common southern pine, S4S, or better, with grade stamp clearly visible.
3. Nails, spikes, lag bolts, anchorages: Size as required; of sufficient strength and character to maintain formwork in place while pouring concrete.
4. Metal or fiberglass forms may be used when approved in writing by the Architect.
5. Where earth is firm enough to permit cutting true sizes, or where rock is cut to true size, concrete for footings or unexposed walls may be placed without forms.

#### 2.2 FORMWORK ACCESSORIES

- A. Form ties: Snap-off metal type of fixed length; minimum working strength of 3000 psi when assembled; free of defects that will leave holes larger than 1" in concrete surface and that will break off at least 1/2" below the surface of concrete.

- B. Water sealing form ties: All liquid retaining concrete structures shall have water sealing form ties such as Burke Inner Rod With Water Seal Washer, Richmond Water seal Snap Ty, or equal.
- C. Form release agent: Colorless mineral oil which will not stain concrete.
- D. Filets for chamfered comers: Rigid foam plastic type; 3/4" x 3/4" size of maximum possible lengths.

## 2.3 CONCRETE ACCESSORIES

- A. Dovetail anchor slots: Minimum 24 gage galvanized steel; release tape sealed slots; bent tab anchors; securable to concrete formwork.
- B. Expansion joint filler: Asphalt impregnated, premolded fiberboard by full thickness of slab or joint meeting requirements of ASTM D994.

## PART 3. EXECUTION

### 3.1 FORMWORK ERECTION

1. Verify lines, levels and centers before proceeding with formwork. Verify that dimensions agree with the Drawings.
2. Construct formwork, shoring, and bracing to meet design and code requirements, so that resultant finished concrete conforms to required shapes, lines and dimensions.
3. Arrange and assemble formwork to permit dismantling and stripping, so that concrete is not damaged during its removal.
4. Align joints and make watertight. Keep form joints to a minimum.
5. Obtain A/E review for use of earth forms. When using earth forms, hand-trim sides and bottoms, and remove loose dirt prior to placing concrete.
6. Arrange forms to allow stripping without removal of principal shores, where and when these are required to remain in place.
7. Obtain A/E review before framing openings in structural members, which are not indicated on the Drawings.

8. Provide bracing to ensure stability of formwork. Prop or strengthen previously constructed formwork likely to be overstressed by construction loads.
9. Provide chamfer strips on exposed comers.
10. Construct formwork to maintain the following maximum tolerances:
  1. Deviation from horizontal and vertical lines:
    1. 1/4" in 10'.
    2. 3/8" in 20'.
    3. 3/4" in 40'.
  2. Deviation of building dimensions indicated on the Drawings and position of columns, walls and partitions: 1/4".
  3. Deviation in cross sectional dimensions of columns or beams or in thickness of slabs and walls: + or -1/4".
11. Provide construction joint forms where concrete placement terminates at the end of a day or because of other reasons.
12. Provide bulkheads, with reinforcing steel penetrating bulkheads, where concrete placement terminates at the end of a day or because of other reasons.
13. Apply form release agent on formwork in accordance with manufacturer's recommendations. Apply prior to placing reinforcing steel, anchoring devices and embedded items.
14. Design and erection of framework shall be the sole responsibility of the Contractor.
15. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings which are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces wet prior to placing concrete.

### 3.2 INSERTS, EMBEDDED PARTS AND OPENINGS

- A. Provide formed openings where required for pipes, conduits, sleeves and other work to be embedded in and passing through concrete members.
- B. Locate and set in place items which will be cast directly into concrete.

- C. Coordinate work of other Sections and cooperate with trades involved in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors and other inserts. Do not perform work unless specifically indicated on the Drawings or reviewed prior to installation.
- D. Install concrete accessories in accordance with manufacturer's recommendations; straight, level and plumb. Ensure items are not disturbed during concrete placement.
- E. Place formed construction joints in floor slab-on-grade in a square or rectangular pattern pouring sequence. Set top screed to required elevations. Secure to resist movement of wet concrete.
- F. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- G. Close temporary ports or openings with tight fitting panels, flush with inside face of forms, neatly fitted so that joints will not be apparent in exposed concrete surfaces.

### 3.3 FIELD QUALITY CONTROL

- A. Inspect and check complete formwork, shoring and bracing to ensure that work is in accordance with formwork design, and that supports, fastenings, wedges, ties and parts are secure.
- B. Inform A/E when formwork is complete and has been cleaned, to allow for inspection. Obtain review prior to placing concrete.
- C. For exposed concrete surfaces, do not reuse wood type formwork more than 3 times without prior inspection and approval of the A/E. Do not patch formwork.
- D. Allow A/E to inspect each section of formwork prior to reuse.

### 3.4 CLEANING

- A. Clean forms as erection proceeds to remove foreign matter. Remove cuttings, shavings and debris from within forms. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
- B. During cold weather, remove ice and snow from within forms. Do not use deicing salts. Do not use water to clean out completed forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

### 3.5 FORM REMOVAL

- A. Notify A/E prior to removing formwork.
- B. Do not remove forms, shores and bracing until concrete has gained sufficient strength to carry its own weight and construction and design load which are likely to be imposed. Verify strength of concrete by compressive test results.
- C. Remove formwork progressively and in accordance with code requirements and so that no shock loads or unbalanced loads are imposed on structure.
- D. Loosen forms carefully. Do not wedge pry bars, hammers or tools against concrete surfaces.
- E. Leave forms loosely in place, against vertical surfaces, for protection until complete removal is reviewed by the A/E.
- F. Store removed forms in a manner that surfaces to be in contact with fresh concrete will not be damaged. Marked or scored forms will be rejected.
- G. Reshore structural members where required due to design requirements or construction conditions and as required to permit progressive construction. Remove load supporting forms only when concrete has attained 80% of required 28 day compressive strength, provided construction is reshored.
- H. Remove forms not directly supporting weight of concrete as soon as stripping operations will not damage concrete.
- I. Removal of formwork at anytime shall be the sole responsibility of the Contractor.

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

1. Reinforcing steel bars and welded steel wire fabric for cast-in-place concrete complete with tie wire.
2. Support chairs, bolsters, bar supports and spacers for reinforcing.

**1.2 RELATED REQUIREMENTS**

- A. Section 03100: Concrete Formwork.
- B. Section 03300: Cast-In-Place Concrete.
- C. Section 04200: Masonry.

**1.3 QUALITY ASSURANCE**

- A. Perform concrete reinforcing work in accordance with CRSI63 and 65 unless specified otherwise.

**1.4 SOURCE QUALITY CONTROL**

- A. Submit certified copies of mill test report of supplied concrete reinforcing, indicating physical and chemical analysis in accordance with Section 01300.

**1.5 REFERENCES**

- A. ACI 318 - Building Code Requirements for Reinforced Concrete.
- B. CRSI - Recommended Practice for Placing Reinforcing Bars.
- C. CRSI 65 - Recommended Practice for Placing Bar Supports, Specifications and Nomenclature.

- D. ASTM A185 - Welded Steel Wire Fabric for Concrete Reinforcing.
- E. ASTM A615 - Deformed and Plain Billet Steel Bars for Concrete Reinforcement.
- F. AWS D1.4 - Reinforcing Steel Welding Code.
- G. ACI 315 - American Concrete Institute Manual of Standard Practice.

## 1.6 SHOP DRAWINGS

- A. Submit Shop Drawings in accordance with Section 01300.
- B. All reinforcing steel shall be detailed in accordance with ACI 315, Details and Detailing of Concrete Reinforcement.
- C. Indicate bar sizes, spacings, locations and quantities of reinforcing steel and wire fabric, bending and cutting schedules and supporting and spacing devices.

## PART 2. PRODUCTS

### 2.1 REINFORCING MATERIALS

- 1. Reinforcing steel: 60 KSI yield grade billet steel bars, ASTM A615, plain finish, conforming to supplemental requirements S1.
- 2. Welded steel wire fabric: Plain type, ASTM A185, in coiled rolls.

### 2.2 ACCESSORY MATERIALS

- A. Tie wire: Minimum 16 gage annealed type.
- B. Bar supports: All surfaces exposed to weather or liquid or which can be seen in service condition shall have plastic tipped bar supports conforming to Class C, D or E as defined in Chapter 9 of CRSI, Placing Reinforcing Bars, 1976 Edition. Where no protection is required, Class A supports may be used.
- C. Other supports: Concrete brick may be used to support reinforcement to obtain proper clearance from earth and rigidity of reinforcement under concreting operations.

## 2.3 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI Manual of Standard Practice, Latest Edition.
- B. Locate reinforcing splices, not indicated on the Drawings, at points of minimum stress. Location of splices to be indicated on Shop Drawings. Unless otherwise indicated, all splices shall be class C.
- C. Weld reinforcing bars in accordance with AWS D1.4.

## PART 3. EXECUTION

### 3.1 PLACEMENT OF REINFORCING STEEL

- 1. Maintain reinforcement surfaces free of rust scale and other coatings which might impair concrete bond as described in Section 7.4 of ACI 318, 1989 edition.
- 2. Handle, place and tie reinforcement steel in accordance with Building Code Requirements for Reinforcing Concrete, ACI 318 and CRSI Placing Reinforcing Bars, 1976 Edition.
- 3. All reinforcement bars shall be supported and secured as directed in ACI 315 and CRSI Manual of Standard Practice, 1990 edition.
- 4. Provide class C tension splices unless indicated otherwise. Do no splicing of reinforcement steel except as authorized by the Architect.
- 5. Accomplish welding in accordance with AWS D1.4 Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction.
- 6. Bend bars cold. Do not field bend bars partially embedded in concrete except as specifically approved by the A/E. Do not heat or cut bars with a torch.

### 3.2 INSTALLING WELDED WIRE FABRIC

- A. After vapor barrier or underfloor waterproofing has been placed, install welded wire fabric.
- B. Locate welded wire fabric in center third of slab.



- C. Lap side one full mesh plus 2". Lap ends 2 full meshes. Offset end laps in adjacent width to prevent continuous laps.

### 3.3 CONCRETE PROTECTION FOR REINFORCEMENT

- A. Protect reinforcing by thickness of concrete indicated.
- B. Where not indicated, thickness of concrete over reinforcing shall be as follows:
  - 1. Where concrete is deposited against the ground without the use of forms - 3".
  - 2. Where concrete is exposed to weather or to ground but placed in forms - 2" for bars larger than no. 5 and 1-1/2" for no. 5 bars and smaller.
  - 3. In slabs and walls not exposed to the ground or to weather - 3/4".
  - 4. In beams, girders and columns not exposed to the ground or to the weather - 1-1/2".
- C. Variation from clear cover shall conform to Section 7.5 of ACI 318, 1989 edition.

END OF SECTION

**PART 1. GENERAL**

**1.1 REQUIREMENTS INCLUDED**

1. Cast-in-place concrete as detailed on the Drawings.
2. Floor slabs on grade, footings, grout fill, utility structures, 'lintel beams and pads.
3. Vapor barrier under slabs on grade.
4. Poured-in-place equipment pads.
5. Surface finish on exposed slabs.
6. Preparation of slabs to receive toppings.
7. Utility kickers and encasement.

**1.2 RELATED REQUIREMENTS**

- A. Section 01400: Quality Control.
- B. Section 02220: Structure Excavation.
- C. Section 02221: Unclassified Excavation for Utilities.
- D. Section 03100: Concrete Formwork.
- E. Section 03200: Concrete Reinforcing
- F. Section 05500: Metal Fabrications.
- G. Division 15 and 16: Items to be cast in concrete.

**1.3 QUALITY ASSURANCE**

- A. Perform cast-in-place concrete work in accordance with ACI 318, unless specified otherwise.

#### 1.4 REFERENCES

- A. ACI 318 - Building Code Requirements for Reinforced Concrete.
- B. ACI 304 - Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.
- C. ACI 305R - Recommended Practice for Hot Weather Concreting.
- D. ACI 306R - Recommended Practice for Cold Weather Concreting.
- E. ACI 301 - Specifications for Structural Concrete for Buildings.
- F. ACI 315 - Details and Detailing of Concrete Reinforcement.
- G. ASTM C33 - Concrete Aggregates.
- H. ASTM C150 - Portland Cement.
- I. ASTM C260 - Air Entrainment Admixtures for Concrete.
- J. ASTM C494 - Chemical Admixtures for Concrete.
- K. ASTM C94 - Ready-Mix Concrete.

#### 1.5 SHOP DRAWINGS

- A. Submit Shop Drawings in accordance with Section 01300.
- B. Submit copies of the concrete mix designs with supporting data to show compliance with ACI 318, Chapter 4 and 5. Indicate types and quantities of materials used, the fresh unit weight, compressive strength, slump, air content and aggregate analysis in mix design.
- C. Submit certification showing that the aggregate, cement and all admixtures conform to these specifications.
- D. Submit copies of each laboratory test report indicating type of concrete furnished, compressive strength, slump, air content and water added to concrete after batching.
- E. Retain ready-mix delivery tickets at the job site for inspection.

## 1.6 TESTING LABORATORY SERVICES

- A. The Contractor shall employ a Testing Laboratory approved by the A/E to perform concrete tests including taking, handling, protecting and storing of test specimens, and the accurate reporting of compressive strength, weight of cylinders, contents of concrete, slump, air contents, and location of concrete. If concrete fails to meet any part of the specifications, immediately notify the A/E for instructions. Additional testing will be at Contractor's expense.
- B. Testing Laboratory shall perform test as follows:
  - 1. Obtain samples: ASTM C31.
  - 2. Compression: ASTM C91.
  - 3. Air content: ASTM C138 (gravimetric method) or ASTM C231 (pressure method).
  - 4. Slump: ASTM C143.
  - 5. Cylinders: One set (6 specimens) for each 150 cubic yards, or fraction thereof, for each 5000 square foot of surface area for slabs, whichever is smaller, of each class of concrete placed each day; test 2 cylinders at 7 days for information and 2 at 28 days for acceptance. If 28 day cylinders do not indicate proper strength, the third set will be tested as directed by the A/E.
- C. The strength level shall be considered satisfactory so long as the averages of all sets of 3 consecutive strength test results equal or exceed the specified strength and no individual test result falls below the specified strength by more than 500 PSI.
- D. Additional tests may be required if evidence of faulty workmanship, failure of test or questionable concrete exists. These tests shall be at Contractor's expense.

## 1.7 EVALUATION AND ACCEPTANCE OF CONCRETE

- A. Concrete strength will be evaluated in accordance with ACI318, section 5.6. Should evidence of low-strength concrete exist, or if test results indicate nonconformance with these specifications, additional testing, as outlined in section 5.6.4 may be directed with the Contractor bearing all costs.
- B. If, after additional testing, evidence of low-strength concrete still exists, load tests in accordance with ACI 318, chapter 20, may be ordered. In the event the concrete is determined to be inadequate, the Contractor will be required to remove it from the project and replace it with concrete conforming to these specifications. All such remedial work shall be at the Contractor's expense.

- C. The Contractor shall be fully responsible for insuring that all concrete and placement meets project requirements. Failure of A/E or Testing Laboratory to detect defective work, workmanship or materials shall in no way prevent rejection and the Contractor being required to take corrective action when such defects are discovered.
- D. Contractor shall provide assistance to Testing Laboratory necessary to gather and store sample cylinders. On site storage and protection shall be provided as required.

## 1.8 CONCRETE QUALITY DESIGN

- A. All concrete mix designs shall be proportioned in accordance with ACI318, section 5.3 (Field Experience and/or Trial Mixtures). Submit mix design for each class of concrete based on a standard deviation analysis or trial mixtures. If a standard deviation analysis is used, the concrete shall achieve an average strength in accordance ACI 318, table 5.3.2.2. Refer to figure 5.3 of ACI 318 Commentary on Building Code Requirements for Reinforced Concrete for outlining this procedure. Submittals made that do not conform to ACI 318, section 5.3 will be rejected.

## PART 2. PRODUCTS

### 2.1 CONCRETE MATERIALS

- 1. Cement: Normal-type I Portland, ASTM C150. Use only one brand through out job.
- 2. Fine and coarse aggregates: ASTM C33. Size coarse aggregate in accordance with ACI 318, chapter 3, paragraph 3.3.2.
- 3. Water: Clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.

### 2.2 ADMIXTURES

- A. Water reducing admixtures: Euclid Eucon WR-75, Master Builders Pozzoloth 200N, or equal conforming to ASTM C494, type A, and not containing more chloride ions than municipal drinking water.
- B. Water reducing, retarding admixtures: Euclid Eucon Retarder-75, Master Builders Pozzoloth 100XR, or equal conforming to ASTM C494, type D, and not containing more chloride ions than municipal drinking water.
- C. High range water reducing admixture (Superplasticizer): Euclid Eucon 37, Master Builders RHEOBUILD 1000, or equal conforming to ASTM C494, type F or G and not containing more chloride ions than municipal drinking water.

- D. Non-chloride accelerator Euclid Accelguard 80, Master Builders HC 534, or equal conforming to ASTM C494, type C or E and not containing more chloride ions than municipal drinking water.
- E. Air entraining admixture: Conforming to ASTM C260.
- F. Calcium chloride: No more than 0.05 percent chloride ions are not permitted.
- G. Certification: From manufacturer certifying to stated requirements.

### 2.3 FLY ASH

- A. Conforming to ASTM C618, class F.

### 2.4 READY-MIX CONCRETE

- A. In Accordance with ASTM C94, alternate no. 2.
- B. Strength (fc):
  - 1. Interior slabs-on-grade: 4000 psi
  - 2. Structural slabs-on-grade: 4000 psi
  - 3. Columns: 4000 psi
  - 4. Beams and lintels: 4000 psi
  - 5. Walls: 4000 psi
  - 6. Prestressed: 5000 psi
  - 7. Footings: 4000 psi
  - 8. Exterior: 4000 psi
  - 9. Utility structures: 4000 psi
  - 10. Utility kickers and encasements: 4000 psi
- C. Contents: In accordance with ACI 302.1 R, table 5.2.7a within specified tolerances. All interior slabs subject to abrasion shall have a maximum air content of 3%. All exterior concrete to have a average content of 4% to 6%.
- D. Water-cement ratio: All concrete exposed to freezing and thawing shall have a maximum water-cement ratio of 0.50. All concrete subjected to deicers and/or required to be watertight shall have a maximum water-cement ratio of 0.45.
- E. Slump: All concrete containing the high range water reducing admixture (superplasticizer) shall have a maximum slump of 8" unless otherwise approved by the Architect. The concrete shall arrive at the job site at a slump of 2" to 3", be verified, then the high range water reducing admixture added to increase the slump to the appropriate level.

- F. All other concrete shall have a maximum slump of 3" for slabs and 4" for other members.
- G. Admixtures: All concrete shall contain the specified water reducing admixture or high range water reducing admixture (superplasticizer). At the Contractors option, both water reducing admixtures may be included in the concrete mix. All concrete slabs placed at air temperatures below 50 degrees F shall contain the specified non-chloride accelerator. All concrete required to be air entrained shall contain the approved air entraining admixture.
- H. Water soluble chloride ion concentrations: Maximum concentrations in hardened concrete at an age of 28 days contributed from the ingredients including water, aggregates, cementitious materials and admixtures shall not exceed the limits established in ACI318, table 4.4.1, unless noted elsewhere in this specification.

## 2.5 VAPOR BARRIER

- A. 6 mil polyethylene sheeting conforming to ASTM E154.

## 2.6 BOND BREAKER

- A. 30 and 90 pound asphalt saturated roofing felt.

## 2.7 CURING AND SEALING COMPOUND

- A. Euclid Super Floor Coat or Super Pliocure, Master Builders Masterseal Dayton J-23 Acrylic Cure or equal conforming to ASTM C309 with minimum 30 percent solids and test data from an independent laboratory indicating a maximum moisture loss of 0.055 grams per sq. cm. in 72 hours when applied at a coverage rate in conformance with the manufacturer's recommendations. Manufacturer's certification required.

## 2.8 SHEET MATERIAL FOR CURING CONCRETE

- A. Waterproof paper or polyethylene film meeting requirements of ASTM C171.

## 2.9 BONDING COMPOUND

- A. Euclid Euco Weld, Larsen Weldcrete, L and M Ever bond or approved equal.

## 2.10 EPOXY ADHESIVE

- A. Euclid Euco Epoxy 463 or 615, L and M Epobond, Sika Sikadur Hi-Mod, Adhesive Engineering Concrecive 1001-LPL or approved equal. The compound shall be 2 component, 100% solids, 100% reactive suitable for user on dry or damp surfaces.

## 2.11 CONCRETE FLOOR FINISHES

- A. Base Bid Concrete Floor Finish: Heavy-duty concrete floor finish shall be installed on all concrete floors where architectural finishes are not specified. This shall include the floors within the Water treatment Plant  
This finish shall be a 30 mil minimum thickness of Inflo Epoxy Topcoat with #4 Series Urethane Glaze Coat as provided by Industrial Floor Service, Inc. of Nashville, TN, or a 30 mil Epoxy/Urethane flooring system as provided by Carboline/Sentry Polymers of Nashville, TN or an approved equal. This coating shall be included in the lump sum base bid cost for Contract "A" Water Treatment Plant
- B. Deductive Alternate No. One-Concrete Floor Finish: Heavy-duty concrete floor finish shall be installed on all concrete floors where architectural finishes are not specified. This shall include the floors within the water treatment Plant. This finish consists of a coating of penetrating epoxy prime with two (2) coats urethane with a total minimum thickness of 10 mils as provided by Industrial Floor Service, Inc., of Nashville, TN or a 10 mil Epoxy/Urethane Floor System provide by Carboline/Sentry Polymers of Nashville, TN or an approved equal. This 'coating shall be included in the bid form as Concrete Floor Finish Deductive Alternate No. One for Contract "A" Water treatment Plant
- C. Deductive Alternate No. Two Concrete Floor Finish: L & M Pentox applied to all concrete floor surfaces where architectural finishes are not specified. This shall include all floors within the Water Treatment Plant  
The compound shall be a 2 component, 100% reactive, non-staining, penetrating epoxy with 30% solids minimum and applied in accordance with manufacturers recommendations. The compound shall provide protection to a minimum of 200 freeze/thaw cycles in accordance with ASTM C672. This coating shall be listed in the bid form as Concrete Floor Finish Deductive Alternate No. Two for Contract "A" Water Treatment Plant

## 2.12 NON-SHRINK GROUT



- D. Euclid Firmix (metallic) and Euco NS (non-metallic), Master Builders Embeco 636 (metallic) and Masterflow 713 (non-metallic), or approved equal. The grout shall conform to CRD-C-612, "Corps of Engineers Specification for Non-Shrink Grout".

### PART 3. EXECUTION

#### 3.1 CONDITION OF SURFACES

1. Notify Testing Laboratory at least 48 hours before starting concrete placement. Do not start concrete placing until Testing Laboratory has approved surfaces, reinforcement placement and embedded items.
2. Place no concrete until reinforcement and embedded items are positioned and secured.
3. Forms, surfaces and trenches shall be free from water, mud, ice, frost and debris when concrete is placed.
4. Wet surfaces before placing concrete.

#### 3.2 VAPOR BARRIER

- A. Place vapor barrier over all crushed stone below slabs-on-grade. Place smoothly, without wrinkles and trapped air. Lap sides and end joints at least 6" and weight down. Turn up 4" at vertical surfaces. Keep unnecessary traffic off vapor barrier.

#### 3.3 BOND BREAKER

- A. Where separation from a vertical surface is desired, place 12" wide strips of 30 pound felt, creased at right angle in the long direction, at all vertical surfaces, except where fiber board is to be installed. Turn up on vertical surfaces for full thickness of concrete.
- B. Where floor slabs bear on tops of foundations, place a 90 pound strip of felt, full width of bearing surfaces.

### 3.4 PRODUCTION OF CONCRETE

- A. Produce all ready-mix concrete in accordance with ACI 301, chapter 7.

### 3.5 PLACING CONCRETE

- A. Prepare place of deposit and equipment. Convey and place concrete in accordance with ACI 301, paragraphs 8.1-8.3. Modifications that follow shall take precedence.
- B. Deposit concrete within 1 hour after water is added to dry batching or use retarding admixture.
- C. Convey concrete promptly to point of use in a manner to prevent separation of ingredients and loss of water. Deposit concrete near its final position to avoid rehandling.
- D. Consolidate concrete, including floor slabs, in accordance with ACI 309 - Guide for Consolidation of Concrete. All concrete shall be vibrated. Maintain at least 1 vibrator on stand-by. Lower frequency vibrators may be used with flowing concrete.
- E. Do not use vibrators to cause concrete to flow.
- F. Concrete column pours shall not extend more than 3/4" into the concrete slab. Chip off any concrete that exceeds this dimension.

### 3.6 CONSTRUCTION JOINTS AND EMBEDDED ITEMS

- A. Construction joints and embedded items shall conform to ACI 301, chapter 6. Locations of all construction joints shall be as shown on the Drawings or approved by the Architect.

### 3.7 FINISHING

- A. After placing concrete, screed to levels and slopes indicated. Do not use tamping tools to force aggregate away from the surface.
- B. When the water sheen has disappeared, use a wood float to bring concrete to a true level or slope as indicated. Depressions between high spots shall not exceed 5/16" under a 10' straightedge after floating, but before troweling.

- C. When trowel finish is required, after concrete has hardened sufficiently to bear a man's weight without imprint, trowel with power and hand tools. Remove small imperfections left by troweling machine and bring to a smooth, dense, polished finish by hand troweling. Continue troweling until a ringing sound is produced as the trowel is moved over the surface.
- D. Do not use dry materials, such as sand and cement, on surfaces during finishing.
- E. Do not use any procedures, such as the addition of water to the concrete surface, that produces a layer of weak material with an increased water-cement ratio at the slab surface.
- F. Maximum allowable variation in troweled surfaces shall be such that depressions between high spots shall not exceed 3/16" under a 10' straightedge.
- G. Where floors are to be covered with a thin set tile, trowel as specified above and then broom surfaces to form a "tooth".

### 3.8 CURING

- A. As finished work is completed, begin curing. Curing may be accomplished by either of the methods described-below, except for items specifically designated for a particular method.
- B. For waterproof paper or plastic film curing, cover damp surfaces and lap edges at 4". Apply weights to prevent displacement. Repair tears and punctures as they occur.
- C. All interior slabs with resilient tile, carpet or left exposed and all exterior slabs, sidewalks, curbs, etc. shall be cured with the specified clear curing and sealing compound. The compound shall be applied immediately after final finishing operations are completed. Apply uniformly in continuous operation by power sprayer or roller in accordance with manufacturer's directions. Recoat areas which are subjected to heavy rainfall within 3 hours after initial application.
- D. Do not use curing and sealing compound on surfaces receiving applied finish other than resilient tile or carpet.
- E. Where forms are left in place, keep forms damp by spraying at frequent intervals for 8 days. Do not allow forms to dry out.

### 3.9 PROTECTION

- A. Protect concrete against traffic for at least 48 hours. Erect barriers as

necessary to protect uncured areas. Provide wood covers to protect concrete step-ups.

- B. Protect concrete from paint, stains and abrasive traffic.

### 3.10 PATCHING

- A. After forms are removed, do not patch or repair, except that fins may be removed back to formed surface, until examined by the Architect. Patch as directed.
- B. Cut out honeycombs, rock pockets, voids over 1/4" in any dimension and holes left by tie rods and bolts, down to the concrete, but in no case to a depth of 1". Make edges of cuts perpendicular to the concrete surface. Before placing cement mortar, thoroughly clean, dampen with water and apply the specified bonding compound. The cement mortar shall be placed after the bonding compound has dried.
- C. Rub exposed interior finished concrete as specified above. Where form marks and fins detract from appearance or are otherwise objectionable, remove by rubbing.
- D. All structural repair shall be made only with approval of Architect, as to method and procedure, using the specified epoxy adhesive and/or epoxy mortar.

### 3.11 GROUTING

- A. All column base plates, equipment bases and other locations noted, shall be grouted with the specified non-shrink grout. All exposed grout shall be nonmetallic.
- B. After steel columns have been erected and shimmed to proper height, grout under column base plates with specified non-shrink grout.

### 3.12 CLEAN-UP

- A. Clean and leave concrete work free from any loose material. Remove any mortar spills from floors or other materials. Leave areas free from any debris.
- B. Remove excess material and equipment from site when work is completed.

END OF SECTION

## **SECTION 04200**

### **MASONRY**

#### **PART 1. GENERAL**

##### **1.01 WORK INCLUDED**

- A. Unit masonry complete with reinforcement and anchorages, complete with lintels over openings.
- B. Mortar for masonry.
- C. Built-in items supplied by other sections.
- D. Cut and fit for work of other sections.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 03110: Concrete Formwork.
- B. Section 03200: Concrete Reinforcement.
- C. Section 03300:-Cast-In-Place Concrete.
- D. Section 07214: Foamed-In-Place Insulation.
- E. Section 07900: Sealants.

##### **1.03 QUALITY ASSURANCE**

- A. Perform masonry work in accordance with requirements of ANSI A41.1 unless indicated otherwise.
- B. Perform mortar work in accordance with requirements ASTM C476 unless indicated otherwise.
- C. All masonry work shall comply with local codes and ordinances.
- D. Coordinate and schedule in a timely manner with the Testing and Inspection Agency. The following quality control items will be required:
  - 1. Verify reinforcing steel for quantity, size and location.
  - 2. Verify placement of coarse grout as indicated in high or low lift procedure.

3. Verify compressive strength of concrete masonry units, mortar, coarse grout, and/or masonry prisms for each 10,000 square feet of surface area as outlined below:
  - a. 3 concrete masonry units shall be tested per ASTM C140.
  - b. 6 mortar cubes shall be tested, 3 at 7 days and 3 at 28 days, per ASTM C109.
  - c. 4 course grout molds shall be tested, 2 at 7 days and 2 at 28 days, per ASTM C39.
  - d. In lieu of individual tests of masonry units, mortar, and grout, as directed by the Architect, perform 1 prism per ASTM E447.

#### 1.04 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during and 48 hours after completion of masonry work.
- B. During freezing or near freezing weather, provide adequate equipment or cover to maintain a minimum temperature of 40 degrees F and to protect masonry work completed or in progress.

#### 1.05 PROTECTION

- A. Maintain protective boards at exposed external corals which may be damaged by construction activities. Provide such protection without damaging completed work.
- B. Keep expansion joints, control joints and air space voids clear of mortar.
- C. Provide temporary bracing during masonry erection. Maintain in place until building structure provides permanent bracing.

### **PART 2. PRODUCTS**

#### 2.01 MASONRY UNITS

- A. Hollow load bearing concrete block (regular and split face): ASTM C90, grade N, type I, modular size complete with comers, bases, lintels and fillers to match and complement block units; standard weight. Provide units with an average strength of 2,250 psi based on net area. No unit shall have a compressive strength of less than 2,000 psi based on net area.
- B. Hollow non-load bearing concrete block: ASTM C129.
- C. Aggregate for concrete block: ASTM C331.

## 2.02 MORTAR MATERIALS

- A. Only one mortar mix shall be used throughout the project. The mortar mix may consist of one of the following combinations, upon approval of the Architect
  - 1. Portland cement, lime and fine aggregate.
  - 2. Masonry cement and fine aggregate.
  - 3. Commercially prepared premix mortar and fine aggregate.
- B. Portland cement: ASTM CI 50, type I.
- C. Masonry cement ASTM C91, for general use.
- D. Aggregates (sand): Standard masonry, Type ASTM C144.
- E. Hydrated lime: ASTM C207 type S or N.
- F. Quicklime: Non-hydraulic, type ASTM C5.
- G. Premix mortar: Commercially prepared type, ASTM C387.
- H. Water: Clean and free from injurious amounts of oil, alkali, organic matter or other deleterious material.
- I. Mortar color: Natural.

## 2.03 REINFORCEMENT AND ANCHORAGES

- A. Reinforcing steel for bond beams: Type as specified in Section 03200.
- B. Horizontal wall reinforcing: ASTM A82, ladder type, trirod if used as tie, (see paragraph B above), plain steel construction: No. 9 gage side rods and cross ties.
- C. Hardware cloth: 1/2" mesh, 19 gage wire, galvanized.

## 2.04 CONCRETE

- A. Concrete for bond beams: 3,000 psi as specified in Section 03300.

## 2.05 MORTAR MIX

- A. Provide Type M in contact with earth, Type M or S for exterior and load bearing.
- B. Thoroughly mix mortar ingredients, in quantities needed for immediate use, according to ASTM C270.

- C. Do not use anti-freeze compounds to lower the freezing point of the mortar.
- D. Use mortar within 2 hours of mixing at temperatures over 78 degrees F and 2-1/2 hours at temperatures under 50 degrees F.
- E. If necessary, retemper mortar within 2 hours of mixing to replace water lost by evaporation. Do not retemper mortar after 2 hours of mixing.

#### 2.06 ACCESSORIES

- A. Control joints: Preformed polyvinyl chloride material; of sizes and profiles as detailed on the Drawings.
- B. Joint filler: Closed cell polyvinyl chloride oversized 50%, self expanding as detailed on the Drawings.

#### 2.07 MASONRY GROUT

- A. Provide masonry grout per ASTM C476.

#### 2.08 MASONRY PRISM STRENGTH

- A. Provide concrete masonry units and mortar when erected, obtain a minimum prism compressive strength of 1,350 psi based on net area.

### **PART 3. EXECUTION**

#### 3.01 SAMPLE PANELS

- A. Prior to the start of any masonry work, lay-up sample panel of each type and combination of masonry materials required for the project. Masonry work started prior to approval of sample will be at the Contractor's own risk. The sample panels shall be of adequate size to indicate the materials, workmanship and appearance for the project.

#### 3.02 PREPARATION

- A. Ensure items built-in by other trades for this work are properly located and sized.
- B. Establish lines, levels and coursing. Protect from disturbances.



### 3.03 INSTALLATION

- A. Place masonry units in accordance with lines and levels indicated on the Drawings.
- B. Fully bond external and internal comers and intersections of load bearing walls.
- C. Buttering comers of joints, deep or excessive furrowing of mortar joints is not permitted.
- D. Do not shift or tap masonry after mortar has taken initial set. Where adjustment must be made, remove mortar and replace.
- E. Perform job site cutting of masonry units with proper power tools to provide straight and true, unchipped edges.
- F. Ensure masonry unit courses are of uniform height. Make vertical and horizontal joints equal and of uniform thickness. Lay in full bed of mortar, properly joined with other work. Mortar head joints prior to placing block.
- G. Remove excess mortar and projections. Take care to prevent breaking masonry comers.
- H. Lay masonry unit courses in running bond unless shown otherwise on the Drawings Course 1 unit and 1 mortar joint to equal 8". Form concave mortar joints unless otherwise noted on the Drawings.
- I. Where non-bearing partitions extend to underside of floor, roof deck or structural system, stop short 3/8" to 1/2" to allow for live load deflection. Fill gap with joint filler. Provide structural anchorage in accordance with ANSI A41.1.
- J. For non-load bearing partitions, leave a 3/8" stacked joint at intersections without mortar. Tie walls with strips of hardware cloth 1" narrower than masonry units and at least 14" long, spaced 16" on centers. Seal joints both sides in accordance with Section 07900 Sealants.
- K. Provide control joints, as approved by the Architect, not to exceed 40' on centers or three times the wall height, whichever is less.
- L. Coordinate placement of veneer with foam-in-place insulation to ensure foam insulation is placed at the required intervals.

### 3.04 TOLERANCES

- A. Maximum variation from masonry unit to adjacent masonry unit is 1/16".

- B. Maximum variation from vertical and horizontal building lines is 1/8" in 10'.

### 3.05 REINFORCEMENT AND ANCHORAGES

- A. Place masonry unit reinforcing and anchorages as follows:
  - 1. Provide walls with horizontal reinforcing in every other mortar joint.
  - 2. Place horizontal reinforcing in first and second joints above and below openings, extend 36" past opening. Place continuous in first and second joint below top of walls.
  - 3. Fully reinforce comers and intersections.
  - 4. Lap masonry reinforcing splices minimum 6".

### 3.06 BOND BEAMS

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

### 3.07 MASONRY GROUT

- A. Fill all block cores solid with masonry grout as indicated on the Drawings.

### 3.08 BUILT-IN WORK

- A. As work progresses, build-in door and window frames, nailing strips, anchor bolts, plates and other items supplied by other trades.
- B. Build-in items plum and true.
- C. Do not build-in organic material which will be subject to rot or deterioration.
- D. Fill door frames in masonry or concrete walls solid with mortar as work progresses.

### 3.09 LINTELS

- A. Provide reinforced masonry unit lintels over openings where detailed on the Drawings.
- B. Construct lintels using concrete and reinforcing specified. Maintain minimum 8 inch bearing on each side of openings, unless noted otherwise on the Drawings.

### 3.010 CUTTING AND FITTING

- A. Cut and fit masonry for chases, pipes, conduit, sleeves and ground. Cooperate fully with other Sections of work to ensure correct size, shape and location.
- B. Architect's review prior to cutting or fitting any areas which are riot indicated on the Drawings, or which may impair appearance or strength of masonry work

### 3.011 CLEANING

- A. Remove excessive mortar and smears upon completion of masonry work.
- B. Point or replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces using a non-acidic solution which will not harm masonry or adjacent materials. Consult masonry manufacturer for acceptable cleaners. Use non-metallic tools in cleaning operations.

END OF SECTION

**PART 1. GENERAL**

**1.01 SECTION INCLUDES**

- A. Shop fabricated steel and aluminum items.

**1.02 RELATED REQUIREMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 03300 - Cast-in-Place Concrete: Placement of metal fabrications in concrete.
- C. Section 04810 - Unit Masonry Assemblies: Placement of metal fabrications in masonry.
- D. Section 09900 - Paints and Coatings: Paint finish.

**1.03 REFERENCE STANDARDS**

- A. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels; 2005.
- B. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels; 2005.
- C. ASTM A 36/A 36M - Standard Specification for Carbon Structural Steel; 2008.
- D. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2007.
- E. ASTM A 123/A 123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2009.
- F. ASTM A 153/A 153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2009.
- G. ASTM A 283/A 283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates; 2003 (Reapproved 2007).
- H. ASTM A 325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2009a.
- I. ASTM A 325M - Standard Specification for Structural Bolts, Steel, Heat Treated 830 MPa Tensile Strength (Metric); 2009.

- J. ASTM A 500/A 500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2010.
- K. ASTM B 26/B 26M - Standard Specification for Aluminum-Alloy Sand Castings; 2009.
- L. ASTM B 85 - Standard Specification for Aluminum-Alloy Die Castings; 2009.
- M. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2007.
- N. ASTM B 209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric]; 2007.
- O. ASTM B 210 - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes; 2004.
- P. ASTM B 210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric); 2005.
- Q. ASTM B 211 - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire; 2003.
- R. ASTM B 211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric); 2003.
- S. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes; 2008.
- T. ASTM B 221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars,-Rods, Wire, Profiles, and Tubes [Metric]; 2007.
- U. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; American Welding Society; 2007.
- V. AWS D1.1/D1.1M - Structural Welding Code - Steel; American Welding Society; 2010.
- W. AWS D1.2/D1.2M - Structural Welding Code - Aluminum; American Welding Society; 2003, and Errata 2004.
- X. SSPC-Paint 15 - Steel Joist Shop Primer; Society for Protective Coatings; 1999 (Ed. 2004).
- Y. SSPC-Paint 20 - Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic"); Society for Protective Coatings; 2002 (Ed. 2004).
- Z. SSPC-SP 2 - Hand Tool Cleaning; Society for Protective Coatings; 1982 (Ed, 2004).

#### 1.04 DESCRIPTION OF WORK

- A. Work described in this section includes metal fabrications, which include items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere. Types of work in this section includes metal fabrications for:

1. Rough Hardware
2. Loose bearing and leveling plates.
3. Loose steel lintels.
4. Miscellaneous framing and supports.

#### 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. Include erection drawings elevations, and details where applicable.
  1. Indicate welded connections using standard AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Welders' Certificates: Submit certification for welders employed on the project, verifying AWS qualification within the previous 12 months.
- D. Samples: Submit representative samples of materials and finished products as may be requested by Architect.

#### 1.06 QUALITY ASSURANCE

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

#### 1.07 PROJECT CONDITIONS

- A. Field Measurements: Where fabrications are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabrication without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting acceptable to fabricator's professional engineer, and in a manner that will not affect structural performance, deflection, safety, etc.

#### 1.08 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation, without delaying the work of this section or the Work of the project.

### PART 2. PRODUCTS

#### 2.01 MATERIALS

- A. Metal Surfaces, General: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade

names and roughness.

## 2.02 MATERIALS - STEEL

- A. Steel Sections: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500, Grade B cold-formed structural tubing.
- C. Plates: ASTM A 283.
- D. Pipe: ASTM A 53/A 53M, Grade B Schedule 40, black finish.
- E. Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1. galvanized to ASTM A 153/A 153M where connecting galvanized components.
- F. Structural Steel Sheet: Hot-rolled, ASTM A 570; or cold-rolled ASTM A 611, Class 1; of grade required for design loading.
- G. Galvanized Structural Sheet Steel: ASTM A 446, of grade required for design loading. Coating designation as indicated, or if not indicated, G90.
- H. Steel Pipe: ASTM A 53; Type and grade (If applicable) as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight (schedule 40), unless otherwise indicated.
- I. Gray Iron Castings: ASTM A 48, Class 30.
- J. Malleable Iron Castings: ASTM A 47, grade as selected by fabricator.
- K. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.
- L. Concrete Inserts: Threaded or wedge type; galvanized ferrous castings, either malleable iron, ASTM A 47, or cast steel, ASTM A 27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A 153
- M. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- N. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.
- O. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20. Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

## 2.03 MATERIALS – ALUMINUM

- A. Extruded Aluminum: ASTM B 221 (ASTM B 221M), 6063 alloy, T6 temper.
- B. Sheet Aluminum: ASTM B 209 (ASTM B 209M), 5052 alloy, H32 or H22 temper.
- C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B 210 (ASTM B 210M), 6063 alloy, T6 temper.
- D. Aluminum-Alloy Bars: ASTM B 211 (ASTM B 211M), 6061 alloy, T6

temper.

- E. Aluminum-Alloy Sand Castings: ASTM B 26.
- F. Aluminum-Alloy Die Castings: ASTM B 85.
- G. Bolts, Nuts, and Washers: Stainless steel.
- H. Welding Materials: AWS D1.2/D1.2M; type required for materials being welded.

#### 2.04 MATERIALS-ACCESSORIES

- A. Grout: Non-Shrink Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with CE-CRD-C621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.
- B. Fasteners:
  - 1. General: Provide zinc-coated fasteners for exterior use or where built into exterior walls. Select fasteners for the type, grade and class required.
- C. Paint:
  - 1. Metal Primer Paint: Southern Coating "Heavy Duty RIP Primer 1 - 0900" Tnemec "10-99 Primer", or approved equivalent.
  - 2. Primer selected must be compatible with finish coats of paint. Coordinate selection of metal primer with finish paint requirements specified in Section 09900 - PAINTING.
  - 3. Galvanizing Repair Paint: High zinc dust content paint for re-galvanizing welds in galvanized steel, complying with Military Specifications MIL-P-21035 (Ships) or SSPC-Paint-20.
  - 4. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, ~y asbestos fibers, or cold-applied asphalt emulsion complying

#### 2.05 FABRICATION

- A. Fit and shop assemble items in largest practical sections, for delivery to site.
- B. Fabricate items with joints tightly fitted and secured.
- C. Continuously seal joined members by continuous welds.
- 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 (if any): 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.

#### 2.06 FABRICATED ITEMS

- A. Ledge Angles, Shelf Angles, Channels, and Plates Not Attached to



Structural Framing: For support of metal decking; prime paint finish.

- B. Lintels: As detailed; galvanized finish.
- C. Miscellaneous framing and supports:
  - 1. Provide miscellaneous steel framing and supports which are not a part of structural steel framework, as required to complete work.
  - 2. Fabricate miscellaneous units to sizes, shapes and profiles shown or, if not shown, of required dimensions to receive adjacent other work to be retained by framing. Except as otherwise shown, fabricate from structural steel shapes and plates and steel bars, of welded construction using mitered joints for field connection. Cut, drill and tap units to receive hardware and similar items.
  - 3. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed. Except as otherwise shown, space anchors 24-inches o.c. and provide minimum anchor units of 1-1/4-inches wide x 1/4-inch x 8-inch long steel straps.
  - 4. Galvanize exterior miscellaneous frames and supports
- D. Rough hardware:
  - 1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in DIVISION 8 sections.
  - 2. Fabricate items of sizes, shapes and dimensions required. Furnish malleable iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

## 2.07 FINISHES – STEEL

- A. Prime paint all steel items.
  - 1. Exceptions: Galvanize items to be embedded in concrete or masonry and items specified on plans for galvanized finish.
  - 2. Exceptions: Do not prime surfaces in direct contact with concrete, where field welding is required, and items to be covered with sprayed fireproofing.
- B. Prepare surfaces to be primed in accordance with SSPC-SP2.
- C. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.
- D. Surface Preparation:
  - 1. Prepare ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specification and environmental exposure conditions of installed metal fabrications:
  - 2. Exterior (SSPC Zone 1B): SSPC-SP6 "Commercial Blast Cleaning.
  - 3. Interiors (SSPC Zone 1A): SSPC-SP3 "Power Tool Cleaning.
- E. Prime Painting: One coat.
- F. Galvanizing of Structural Steel Members: Galvanize after fabrication to ASTM A 123/A123M requirements.
- G. Galvanizing of Non-structural Items: Galvanize after fabrication to ASTM A 123/A 123M requirements.

- H. ASTM A 386 for galvanizing assembled steel products.
- 2.08 FINISHES-ALUMINUM
  - A. High Performance Organic Coating System: AAMA 2604 multiple coat, thermally cured fluoropolymer system; color as selected from manufacturer's standard colors. (Where indicated - prefinished aluminum, on interior.)
  - B. Superior Performance Organic Coating System: AAMA 2605 multiple coat, thermally cured polyvinylidene fluoride system; color as selected from manufacturer's standard colors. (Where indicated - prefinished aluminum, on exterior)
  - C. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.
- 2.09 FABRICATION GENERAL
  - A. Workmanship:
    - 1. Use materials of size and thickness shown or, if not shown, of required size and thickness to produce strength and durability in finished product. Work to dimensions shown or accepted on shop drawings, using proven details of fabrication and support. Use type of materials shown or specified for various components of work.
    - 2. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32- inch unless otherwise shown. Form bent metal comers to smallest radius possible without causing grain separation or otherwise impairing work.
    - 3. Weld comers and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.
    - 4. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners wherever possible. Use exposed fasteners of type shown, or if not shown, Phillips flat-head (countersunk) screws or bolts.
    - 5. Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
    - 6. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.
    - 7. Fabricate joints which will be exposed to weather in a manner to exclude water or provide weep holes where water may accumulate.
- 2.10 FABRICATION TOLERANCES
  - A. Squareness: 1/8 inch maximum difference in diagonal measurements.
  - B. Maximum Offset Between Faces: 1/16 inch.
  - C. Maximum Misalignment of Adjacent Members: 1/16 inch.
  - D. Maximum Bow: 1/8 inch in 48 inches.
  - E. Maximum Deviation From Plane: 1/16 inch in 48 inches.

## 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 and aluminum where site welding is required.
- B. Supply setting templates to the appropriate entities for steel items required to be cast into concrete or embedded in masonry.
- C. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Do not delay job progress; allow for trimming and fitting where taking field measurements before fabrication might delay work.
- D. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete insets, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

### 3.03 INSTALLATION

- A. Install items plumb and level, accurately fitted, free from distortion or defects.
- B. Provide for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.
- C. Field weld components indicated.
- D. Perform field welding in accordance with AWS D1.1/D1.1M.
- E. Obtain approval prior to site cutting or making adjustments not scheduled.
- F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

### 3.04 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch.
- C. Maximum Out-of-Position: 1/4 inch.

END OF SECTION

## **SECTION 06100**

### **ROUGH CARPENTRY**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Miscellaneous wood blocking and furring
- B. Preservative treatment of wood members where required.
- C. Behind wall wood blocking for support of washroom accessories.
- D. Plywood panels for mounting electrical and telephone equipment

##### **1.02 RELATED REQUIREMENTS**

- A. Section 06200: Finish Carpentry.
- B. Section 09260: Gypsum Board Systems.

##### **1.03 QUALITY ASSURANCE**

- A. Lumber to have visible grade stamp, of an agency certified by NFPA.
- B. Submit certification of moisture content and for treated wood; certificate of preservative treatment.

##### **1.04 REFERENCES**

- A. PS 1 - Construction and Industrial Plywood.
- B. PS 20 - American Softwood Lumber Standard.
- C. APA - American Plywood Association.
- D. FS TT-W-550 - Wood Preservative, Chromated Copper Arsenate Mixture.
- E. FS TT-W-571 - Wood Preservation: Treating Practices.

## **PART 2 PRODUCTS**

### **2.01 LUMBER AND SHEET MATERIALS**

- A. Lumber PS 20, and graded in accordance with NFP A Grading Rules; kiln-dried with maximum moisture content of 19%; Douglas Fir or Southern Pine species, No. 2 grade.
- B. Plywood with APA grade mark and thickness as shown on the Drawings.

### **2.02 ACCESSORIES**

- A. Nails, spikes and staples: Galvanized for exterior locations, high humidity locations, and treated wood; plain finish for other interior locations; size and type to suit application.
- B. Bolts, nuts, washers, lags, pins and screws: Medium carbon steel; sized to suit application; galvanized for exterior locations, high humidity locations, and treated wood; plain finish for other interior locations.
- C. Fasteners: Toggle bolt type for anchorage to hollow masonry, expansion shield and lag bolt type for anchorage to solid masonry or concrete, bolts or power activated type for anchorage to steel.

### **2.03 WOOD PRESERVATIVE AND TREATMENT**

- A. Wolman salt treatment meeting the requirements of FS TT-W-550 and the treating process and the results thereof meeting FS TT-W-571.

## **PART 3 EXECUTION**

### **2.04 PLACEMENT**

- A. Place miscellaneous blocking, furring, canting, nailing strips, framing and sheathing. Place members true to lines and levels. Secure rigidly in place.
- B. Space miscellaneous furring at 16" on center, unless noted otherwise on the Drawings.
- C. Construction members of continuous pieces of longest possible lengths.

- D. Use decay and insect resistant lumber in contact with cementitious material roofing, steel and related metal flashings. Brush on 2 coats of preservative treatment on site- sawn ends. Allow to cure before placement.

END OF SECTION

**SECTION 06200**  
**FINISH CARPENTRY**

**PART 1 GENERAL**

1.01 REQUIREMENTS INCLUDED

- A. Finish carpentry items, complete with required hardware and attachments accessories.
- B. Installation of finish hardware.

1.02 RELATED REQUIREMENTS

- A. Section 06100: Rough Carpentry.
- B. Section 08100: Fiberglass Reinforced Polyester (FRP) Doors.
- C. Section 08700: Finish Hardware.
- D. Section 09900: Painting.

1.03 QUALITY ASSURANCE

- A. Perform finish carpentry work in accordance with the recommendations of the Millwork Standards of the Architectural Woodwork Institute (AWI).

1.04 REFERENCES

- A. FS MM-L-736C Lumber - Hardwood.
- B. MIL-L-1914C Lumber and Plywood, Fire Retardant Treated,
- C. FS MMM-A-130A - Adhesive, contact
- D. AWI - Architectural Woodwork Institute.
- E. APA - American Plywood Association.
- F. FS L-P-508F - Plastic Sheet, Laminated, Decorative and non-Decorative.
- G. PS20 - American Softwood Lumber Standard.

- H. PS 1 - Construction and Industrial Plywood.
  - I. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
- 1.05 SAMPLES
  - A. Submit samples of colors and patterns of plastic laminate and paneling.
- 1.06 SHOP DRAWINGS
  - A. Submit shop drawings in accordance with Section 01300.
  - B. Indicate materials, component profiles, fastening, jointing details, finishes, accessories, etc.
- 1.07 DELIVERY AND STORAGE
  - A. Do not deliver finish carpentry items until site conditions are adequate to receive the work of this section. Protect materials from weather while in transit
  - B. Store indoors, in ventilated areas with a constant but minimum temperature of 60 degrees F and maximum relative humidity of 25% to 55%.

## **PART 2 PRODUCTS**

- 2.01 LUMBER PRODUCTS
  - A. Softwood lumber: PS 20; graded in accordance with requirements of AWI; maximum moisture of 10% for exterior work; fir or white pine.
- 2.02 SHEET MATERIALS
  - A. Softwood plywood: PS 1; graded in accordance with AWI; core material of veneer of thickness and grade mark indicated on the Drawings; white pine or white spruce.
  - B. Wood particle board: Composed of wood chips, shavings or flakes made with high waterproof resin binders of grade to suite application; sanded faces.
  - C. Hardboard: Pressed wood fiber with resin binder; tempered grade.
- 2.03 SOFFIT
  - A. Vinyl perforated soffit: Pro-Tech Plus Double 5", .042", fully vented soffit, or equal, complete with trim. Colors to be selected.



## 2.04 ACCESSORIES

- A. Nails: Size and type to suit application.
- B. Bolts, nuts, washers, lags, pins and screws: Size and type to suit application.

## **PART 3 EXECUTION**

### 3.01 Fabrication

- A. Fabricate the work of this section in strict accordance with die original design and the approved Shop Drawings.

### 3.02 INSTALLATION

- A. Perform finish carpentry work to extent indicated. Construction joining and prefinishing of assemblies and items: Custom grade as established by AWI.
- B. Set and secure materials and components in place rigid, plum, and square.
- C. Ensure all mechanical and electrical items affecting this section of work are properly placed, complete, and have been inspected by Architect prior to commencement of installation.
- D. Install hardware in accordance with manufacturer's recommendations.
- E. Brush apply 2 coats of preservative treatment to site-sawn ends. Allow to cure before placement.

### 3.03 CLEANING AND ADJUSTMENT

- A. Upon completion of the installation, visually inspect each installed item, thoroughly clean all surfaces by using the cleaning material recommended by the manufacturer of the finish being cleaned, and carefully adjust all operating components for optimum operation.

END OF SECTION

## **SECTION 07110**

### **SHEET MEMBRANE WATERPROOFING**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Clean and patch surfaces.
- B. Apply waterproofing.
- C. Seal joints and protrusions through waterproofing.
- D. Protective board covering.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 03300: Cast-In-Place Concrete.

##### **1.03 REFERENCES**

- A. ASTM D41 - Primer for Use with Asphalt in Dampproofing and Waterproofing.
- B. ASTM D449 - Asphalt for Dampproofing and Waterproofing.
- C. ASTM D491 - Asphalt Mastic for use in Waterproofing.
- D. ASTM C208 - Insulating Board (Cellulosic Fiber) Structural and Decorative.

##### **1.04 PRODUCT DATA**

- A. Submit manufacturers instructions for surface preparation and application for review of Architect in accordance with Section 01300.

##### **1.05 ENVIRONMENTAL REQUIREMENTS**

- A. Do not apply membrane waterproofing on damp or frozen surfaces.
- B. Ensure temperatures are maintained at minimum 40 degrees F for 24 hours before application and continuously until waterproofing membrane has cured.
- C. Provide ventilation when waterproofing is in an enclosed space.

## 1.06 WARRANTY

- A. Guarantee shall provide for making good, within warranty period, at no cost to the Owner, failures of waterproofing to resist penetration of water except where such failures are the result of structural failures of the building. Hairline cracking of concrete due to temperatures or shrinkage is not considered as structural failure.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Self adhering, preformed pliable membrane of rubberized asphalt integrally bonded to polyethylene sheeting, complete with primers, accessories and protection board required for complete and watertight installation meeting requirements for manufacturer's warranty tested in accordance with the following test methods:
  - 1. Pliability: ASTM D146, 180 degree bend over 1" mandrel at -25 degrees F.
  - 2. Tensile Strength: ASTM D412 (Die C) modified, 250 psi minimum.
  - 3. Elongation-ultimate failure of rubberized asphalt ASTM D412 (Die C) modified, 300% minimum.
  - 4. Cycling over 1" joint at -15 degrees F: Grace Test 1000 cycles, no effect
  - 5. Peel Adhesion: Grace Test 5.0 lb./inch.
  - 6. Puncture Resistance: ASTM EI 54, bituthene membrane stretched by blunt object/40 lb. minimum.
  - 7. Resistance to Hydrostatic Head: Grace Test, 150 ft. of water minimum.
  - 8. Exposure to Fungi in Soil: GSA-PBS 07111, 16 weeks, unaffected.
  - 9. Permeance-Perms: ASTM E96, Method B, 0.1 grains/sq. ft./hr./in.
  - 10. Water Absorption-72 hrs.: ASTM D1228, 0.25% by weight maximum.
- B. Protective cover ASTM C208; 1/2" thick asphalt impregnated wood fiber board.

## PART 3 EXECUTION

### 3.01 SURFACE PREPARATION

- A. Clean and prepare surfaces to receive waterproofing, in accordance with manufacturer's recommendations.
- B. Ensure surfaces are firm, and free from frost, loose particles, cracks, pits, rough projections, grease, oil and other foreign matter detrimental to adhesion and monolithic application of waterproofing.

### 3.02 APPLICATION:

- A. Clean and prepare surfaces to receive waterproofing, in accordance with manufacturer's recommendations.
- B. Ensure surfaces are firm, and free from frost, loose particles, cracks, pits, rough projections, grease, oil and other foreign matter detrimental to adhesion and monolithic application of waterproofing.
- C. Seal around items and services projecting through waterproofed surfaces. Apply in accordance with manufacturer's recommendations. Ensure sealed areas are water tight.
- D. Protect membrane waterproofing from damage during backfill operations by adhering protection board over treated surfaces. Neatly fit boards around pipes and projections. Use Mastic or hot asphalt board.

END OF SECTION

## **SECTION 07210**

### **THERMAL INSULATION**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Sound attenuation insulation.
- B. Blowing insulation and vapor retarder for attic spaces.
- C. Batt insulation for packing perimeter window and door shim spaces and crevices in exterior wall.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 09260: Gypsum Board Systems.

##### **1.03 REFERENCES**

- A. FS L-P-375C - Plastic Film, Flexible, Vinyl-Chloride.
- B. FS HH-I-521E - Insulation Blankets, Thermal Fiber, for Ambient Temperatures:

##### **1.04 DELIVERY OF MATERIALS**

- A. Furnish material in manufacturers packaging, complete with installation instructions.

##### **1.05 PRODUCT DATA**

- A. Submit manufacturers data and installation instructions in accordance with Section 01300.

#### **PART 2 PRODUCTS**

##### **2.01 MATERIALS**

- A. Sound attenuation: Unfaced, formaldehyde-free blankets shall have an R-value of R- 11 for 3 ½" as indicated on the Drawings.
- B. Ceiling (attic) insulation: Standard blowing fiberglass insulation conforming to ASTM C764, Type I, Category 2. Insulation shall have an R-value of R-30 and a minimum thickness of 12 ¾" weighing not less than .638 pounds per square foot

- C. Ceiling vapor retarder. Translucent polyethylene film, as recommended for use in above grade building construction, 4 mil thick
- D. Nails and staples: Of electroplated, galvanized steel wire; type and size recommended for application.
- E. Tape: 2" wide self adhering type; bright aluminum faced.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install batt insulation in exterior walls without visible gaps or separations.
- B. Cut and trim insulation neatly, to fit spaces. Use batts free of ripped backs or edges.
- C. Install batt, blowing insulation, and vapor retarder in accordance with manufacturer's recommendations. Install after mechanical and electrical services within walls have been installed.
- D. Fit insulation tight within spaces and tight to and behind mechanical and electrical services within the plane of insulation. Leave no gaps or voids.
- E. Place vapor retarder adjacent to interior face of gypsum board by nailing or stapling in place at maximum 6" on center and tape seal to framing members. Tape seal areas where, nails or staples penetrate vapor barrier.
- F. Extend vapor retarder tight to full perimeter of adjacent window, door frames, attic access and other items interrupting the plane of membrane. Tape seal in place.

**END OF SECTION**

## **SECTION 07214**

### **FOAMED-IN-PLACE INSULATION**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Complete filling of all concrete masonry unit cores unless specified to receive concrete.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 04200: Masonry.

##### **1.03 SUBMITTALS|**

- A. Submit manufacturer's data and installation instructions in accordance with Section 01300.

##### **1.04 REFERENCES**

- A. ASTM E84 - Flamespread and Smoke Development.
- B. ASTM D2015 - Moisture Absorption.
- C. ASTM C117 - Thermal Conductivity.

##### **1.05 DELIVERY OF MATERIALS**

- A. Furnish material in manufacturers packaging, complete with installation instructions.

#### **PART 2 PRODUCTS**

##### **2.01 MATERIALS**

- A. Thermco by Thermal Corporation of America, Cor-Fill-500 by Tailored Chemical Products, Inc., or approved equal.
- B. Minimum physical properties:
  - 1. ASTM E84 - Fuel contributed: 0.
  - 2. ASTM E84 - Flamespread: 5.
  - 3. ASTM E84 - Smoke Development: 75.

4. ASTM CI 17 - Thermal Conductivity: 1" thickness at 75° 4.5R.
5. ASTM EI 19 - Fire wall rating: 3 hour and 30 minutes.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- B. Install insulation in a timely, coordinated manner as the work progresses. Fill all voids of all concrete masonry units, both exterior and interior walls.
- B. Installation shall be by a manufacturer approved installer in strict accordance with manufacturer's requirements.
- B. Protect walls after installation from moisture for 24 hours.

#### **3.02 EQUIPMENT**

- A. Equipment for mixing and installing the insulation shall be of a type approved and certified by the manufacturer.

END OF SECTION



## **SECTION 07900**

### **SEALANTS**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Clean and prepare joint surfaces.
- B. Sealant, caulk and backing materials as required.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 04200: Masonry
- B. Section 06200: Finish Carpentry.
- C. Section 08100: Fiberglass Reinforced Polyester (FRP) Doors,
- D. Section 08400: Entrances and Storefront.
- E. Section 09260: Gypsum Board Systems.
- F. Section 11601: Steel Laboratory Casework.
- G. Section 13500: Pre-Engineered Structure.

##### **1.03 REFERENCES**

- A. FS TT-S-1543 - Sealing compound, silicone rubber base.
- B. ASTM C920 - Specifications for Non-Sag, Class 25 Sealants, without primer.
- C. ASTM C834 - Acrylic latex, one part.

##### **1.04 SUBMITTALS**

- A. Submit manufacturer's product data for surface preparation and installation in accordance with Section 01300.
- B. Submit color chart for selection.

## 1.05 WARRANTY

- A. Provide 1 year warranty in accordance with the Contract
- B. Warranty: Replace sealants which fail because of loss of cohesion or adhesion, or do not cure.

## PART 2 PRODUCTS

### 2.01 SEALANT MATERIALS

- A. Exterior sealant: Morton Thiokol 1P, single component, liquid polysulfide polymer, or equal conforming to requirements of ASTM C920, color as selected by the Architect
- B. Interior caulk: Acrylic latex, one part, conforming to requirements of ASTM C834.

### 2.02 ACCESSORIES

- A. Primer Non-staining type, recommended by sealant manufacturer to suit application.
- B. Joint cleaner Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
- C. Joint filler: ASTM D1056, round open cell foam rod; oversized 30% to 50%.
- D. Bond breaker. Pressure sensitive tape recommended by sealant manufacturer to suit application.

## PART 3 EXECUTION

### 3.01 INSPECTION

- A. Verify joint dimensions, physical and environmental conditions are acceptable to receive work of this Section.
- B. Beginning of installation means acceptance.

### 3.02 PREPARATION

- A. Clean, prepare and size joints in accordance with manufacturer's instructions. Remove any loose materials and other foreign matter which might impair adhesion of sealant

- B. Verify that joint shaping materials and release tapes are compatible with sealant
- C. Examine joint dimensions and size materials to achieve required width/depth ratios.
- D. Use joint filler to achieve required joint depths, to allow sealants to perform properly.
- E. Use bond breaker where required

### 3.03 INSTALLATION

- A. Install sealant in accordance with manufacturer's instructions.
- B. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges.
- C. Tool joints concave.
- D. Joints shall be free of air pockets, foreign embedded matter, ridges and sags.

END OF SECTION

## **SECTION 08100**

### **FIBERGLASS REINFORCED POLYESTER (FRP) DOORS**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Furnish and install fiberglass reinforced polyester doors with fiberglass frames and continuous hinges.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 04200: Masonry.
- B. Section 07900: Sealants.
- C. Section 08700: Hardware.

##### **1.03 SYSTEM PERFORMANCE**

- A. Provide door assemblies that have been designed and fabricated to comply with requirements for the following:
  - 1. Thermal transfer U-value of not more than 0.09 (BTU/hour. x sf x degrees F per AAMA 1503.01.
  - 2. Flame spread exterior face: ASTM E84 not greater than 145 (Class C).
  - 3. Flame spread interior face: ASTM E84 not greater than 10 (Class A).
  - 4. Smoke developed exterior face: ASTM E84 not greater than 345 (Class C).
  - 5. Smoke developed interior face: ASTM E84 not greater than 320 (Class A).
  - 6. Impact Strength ASTM D256: 13.5 nominal
  - 7. Abrasion Resistance ASTM D1242: .23% nominal.
  - 8. Weatherability ASTM D570: .20%-.40% nominal.
  - 9. Hardness ASTM D2583: 50 nominal (Barcol meter reading).

##### **1.04 QUALITY ASSURANCE**

- A. Standards: Comply with the requirements and recommendations in applicable specifications and standards by NAAMM and AAMA.
- B. Performance: A minimum of ten year record of production of frames, doors and panels.
- C. Instruction: The manufacturer shall be available for consultation, including instructing installation personnel.

- D. Field measuring: Field verify all information prior to fabrication.

#### 1.05 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300.
- B. Shop Drawings shall include elevations, detail sections of composite members, hardware mounting heights, anchorages, reinforcement, expansion provisions and glazing.
- C. Submit 6" samples of each type and color and 12" long sections of extrusions or formed shapes.
- D. Submit product data including manufacturer's specifications, standard details, and installation recommendations.

#### 1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to job site in their original, unopened packages with labels intact. Inspect materials for damage and advise manufacturer immediately of any unsatisfactory materials.
- B. Package door assemblies in individual corrugated containers so no portion of the door has contact with the outer shell of the container. Package and ship frames preassembled.

#### 1.07 WARRANTY

- A. Provide ten (10) year warranty for replacement of doors and frames because failure of workmanship including excessive deflection, faulty operation, deterioration of finish, or construction in excess of normal weathering and defects in hardware installation.

### **PART 2 PRODUCTS**

#### 2.01 MATERIALS

- A. Fiberglass reinforced polyester doors: Special-Lite, Inc. or approved equal SL-17, 1 3/4" thick constructed of 6063-T5 aluminum stiles and rails minimum 2 5/16" depth. Door face to be 120" thick pebble embossed fiberglass reinforced polyester, color selected from manufacturer's full range. Core, 5 pounds per cubic foot density polyurethane free of CFC and HCFC, minimum R-value of 11.

- B. Rated fiberglass reinforced polyester doors: Special-Lite, Inc. or approved equal SL- 21 with 45 minute fire assembly rating.
- C. Framing system: Special-Lite, Inc. or approved equal AF-150, 2" x 5 ¾" All Fiberglass frames for doors in drywall partitions.
- D. Framing system: Special-Lite, Inc. or approved equal AF-150, 2" x 5 ¾". All Fiberglass 5 ¾" framing for interior and exterior doors in masonry walls.
- E. Hinges: Special-Lite SL-120 continuous.

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Comply with manufacturer's recommendations and specifications for the installation of doors and frames.
- B. Set units plumb, level and true to a line, without warp or rack of doors or frames. Anchor securely in place.
- C. Set thresholds in a bed of mastic and back seal.
- D. Provide adjustment tools and instruction sheets.

END OF SECTION

**SECTION 08305**  
**ATTIC ACCESS DOORS**

**PART 1 GENERAL**

1.02 REQUIREMENTS INCLUDED

- A. Furnish and install attic access doors.

1.03 RELATED REQUIREMENTS:

- A. Section 06200: Finish Carpentry.
- B. Section 09900: Painting.

1.04 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300.

**PART 2 PRODUCTS**

2.01 ATTIC ACCESS DOORS

- A. Frame constructed of 16 gage steel with 14 gage door:
- B. Galvanized drywall bead.
- C. Double acting concealed spring hinge allowing door to swing 175 degrees.
- D. Lock to be cylinder type with 2 keys.
- E. Size to be 22" x 36".
- F. Entire assembly to be factory phosphate dipped and primed,

**PART 3 EXECUTION**

3.01 INSTALLATION

- A. Install in accordance with manufacturer's printed instructions.

END OF SECTION

**SECTION 08330**  
**OVERHEAD INSULATED COILING DOORS**

**PART 1 GENERAL**

1.01 REQUIREMENTS INCLUDED

- A. Insulated overhead coiling doors, manually operated.

1.02 RELATED REQUIREMENTS

- A. Section 13500: Pre-Engineered Structure.

1.03 REFERENCES

- A. FS QQ-S-775 - Steel Sheets, Carbon, Zinc-coated (Galvanized) by the Hot Dip Process.

1.04 SHOP DRAWINGS AND PRODUCT DATA

- A. Submit shop drawings, manufacturer's data and installation instructions in accordance with Section 01300.
- B. Clearly indicate dimensioning, general construction, component connections, configurations, anchorage and fastening methods, hardware locations and installation details.

1.05 DELIVERY OF MATERIALS

- A. Deliver doors in manufacturer's packaging complete with installation instructions.

**PART 2 PRODUCTS**

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer and type: Overhead Door Corporation UFN1 Stormtight Insulating Coiling Door.
- B. Other acceptable manufacturers:
  - 1. McKeen Door.
  - 2. Kinnear.
  - 3. W-D Door Inc./North American.



## 2.02 OVERHEAD COILING DOORS

- A. Operation: Hand chain.
- B. Finish: Factory painted, color selected.

## 2.03 COMPONENTS

- A. Curtain: F-265122 gage interlocking slats and 24 gage back cover of factory primed galvanized steel 2-5/8" wide x required length. Ends of alternate slats to be fitted with end locks to act as wearing surface in guides and to prevent lateral movement Bottom to be fitted with angles to provide reinforcement and positive contact with floor when curtain is closed.
- B. Curtain Guides: Three structural steel angles of required sizes and configurations.
- C. Roller Shaft (Counterbalance): Steel pipe and helical steel spring system capable of producing sufficient torque to assure easy operation of curtain from any position, adjustable spring tension.
- D. Hood: 24 gage galvanized factory primed steel, internally reinforced to maintain rigidity and form. Provide internal hood baffle/lintel weatherseal.
- E. Weatherstripping: Full height PVC seal on each guide, frill door with flexible seals and heavy duty loop bottom seal.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install overhead coiling doors in accordance with manufacturer's recommendations.
- B. Fit, align and adjust complete door assembly level and plum, and to provide smooth operation.

END OF SECTION

**SECTION 08400**  
**ENTRANCES AND STOREFRONTS**

**PART 1 GENERAL**

**1.01 REQUIREMENTS INCLUDED**

- A. Aluminum Doors.
- B. Aluminum Storefront Framing System.
- C. Hardware.

**1.02 RELATED REQUIREMENTS**

- A. Section 08700: Hardware (cylinders only).
- B. Section 08800: Glass and Glazing.

**1.03 CERTIFICATION**

- A. Certify that:
  - 1. The openings in which the work of this Section was installed were all in condition suitable for that installation.
  - 2. The materials installed complied in all respects with the requirements of this Section.
  - 3. The materials were installed in complete accordance with the manufacturer's recommendations.

**1.04 SHOP DRAWING AND PRODUCT DATA**

- A. Submit shop drawings and product data in accordance with Section 01300.
- B. Indicate general construction, configurations, jointing methods, reinforcements and locations of cut-outs for glass and louvers.
- C. Complete materials list of all items proposed to be furnished and installed under this Section.
- D. Sufficient data to demonstrate compliance with all specified requirements.
- E. Samples of the specified finish showing lightest and darkest finish to be supplied for this work.

- A. Manufacturer's recommended methods of installation which, when approved by the Architect, will become the basis for inspecting and accepting or rejecting actual installation methods used on the job.
- B. Manufacturer's Certifications: Upon completion of this portion of the work, and as a condition of its acceptance, submit the certification required by above.

#### 1.05 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials of this Section before, during and after installation and to protect tire work and materials of all other trades.
- B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no cost to the Owner.

### **PART 2 PRODUCTS**

#### 2.01 TYPE

- A. All entrances and storefronts for this work, unless otherwise specifically approved by the Architect, shall be the product of one manufacturer.
- B. Entrances and storefront design for this work is based on Kawneer and the numbers shown are Kawneer numbers. Products of other manufacturers that are equal of quality and performance will be acceptable.

#### 2.02 MATERIALS

- A. Provide aluminum extruded from 6063-T5 alloy, finished in AA-M12 C22 A31 No.17 Clear throughout.
  - 1. Framing system: EnCORE, 4 ½" System, 1" infill, thermally broken.
  - 2. Door Medium stile 350 with minimum 7-1/2" bottom.
  - 3. Accessories: Single door, single acting with the following:
    - a. Push/Pull: CPII/CO-9.
    - b. Closer: Standard overhead, painted finish.
    - c. Hinges: 2 standard 4 ½" x 4" butt type.
    - d. Deadlock: Adams-RiteMS 1890.
    - e. Cylinder: With thumb turn specified in 08700.
    - f. Weathering: Sealair weathering system; EPDM blade gasket sweep strip applied to the bottom of door.
    - g. Threshold: Standard H/C butt hung.

## **PART 3 EXECUTION**

### **3.01 FABRICATION**

- A. Shop prefabricate all doors and frames into complete units, verifying all measurements at the job site prior to fabrication.
- B. Accurately miter and fit all members to hairline joints.
- C. Weld or mechanically fasten along entire line of contact on the unexposed side.
- D. No discolorations on the face after anodizing will be acceptable.

### **3.02 SURFACE CONDITIONS**

- A. Prior to installation of the work of this section, carefully inspect the installed work of other trades and verify that all such work is complete to the point where the installation may properly commence.
- B. Verify that storefront systems may be installed in complete accordance with the original design and the approved shop drawings.
- C. In the event of discrepancy, immediately notify the Architect.
- D. Do not proceed with installation in areas of discrepancies until such discrepancies have been resolved.

### **3.03 INSTALLATION**

- A. Install all members with adequate provision for settling, expanding and contracting to occur without breaking glass.
- B. Firmly anchor all members, using all anchoring devices required to ensure positive attachment of the members for long life under hard use.
- C. Wherever aluminum is in contact with steel, concrete or other material potentially creative of electrolytic action, provide all required permanent isolation of the aluminum by backpainting with first quality bituminous paint or by such other isolation as is approved in advance by the Architect.
- D. Protect all finished surfaces as necessary to prevent damage during progress of the work.

#### 3.04 CLEANING UP

- A. Immediately prior to acceptance of the work, remove all protective materials from the storefront system and clean all exposed members.
- B. Do not use abrasive or harmful cleaning agents.

END OF SECTION

## **SECTION 08700**

### **HARDWARE**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Hardware for interior and exterior doors.
- B. Threshold and weatherstripping for exterior doors.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 06200: Finish Carpentry.
- B. Section 08100: Fiberglass Reinforced Polyester (FRP) Doors.
- C. Section 08400: Entrances and Storefronts.

##### **1.03 REFERENCES**

- D. ANSI A115.2 - Door and Frame Preparation for Bored or Cylindrical Locks for 1-3/4" Doors.
- E. ANSI A156.1 - Butts and Hinges.

##### **1.04 KEYING**

- A. Door locks: Keyed differently, keyed alike and master keyed, as directed. Stamp all keyed alike keys with group number and stamp keyed differently keys with door numbers.
- B. Supply 2 keys for each lock and 4 master keys.

##### **1.06 SHOP DRAWINGS**

- A. Submit in accordance with Section 01300.

#### **PART 2 PRODUCTS**

##### **2.01 HARDWARE**

- A. Provide items as listed in the hardware schedule complete to function as intended.

- B. Similar items of same function and performance by other manufacturers will be acceptable.
- C. Promptly furnish templates to avoid delays.
- D. Hardware Group A - Door 100A
  - 1. Cylinder: For storefront as specified in 08400 (satin chrome 26D)
- E. Hardware Group B - Doors 105B, 106A, 106B, 106D, 200A, 200B, 300A
  - 1. Narrow rim type mortised exit device: Sargent 8300 Series with 700-4 series ET lever control, Von Duprin Series 35L with 06 outside lever or Yale 7200 with matching exterior lever (satin stainless steel US32D)
  - 2. H/C Closer: LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)
  - 3. H/C threshold: Zero 564, National Guard 896 or Pemko 2005AS (Aluminum US28)
  - 4. Weatherstripping: Zero 328A, National Guard 137N or Pemko 319CN (Aluminum US28)
  - 5. Head protection: Zero 142, National Guard 16AD or Reese R201A (Aluminum US28)
- F. Hardware Group C-Door 109A
  - 1. Entrance/office lockset-lever Sargent 10G05-LNL, SchlageD50PD-OLY or Yale 5407L-AU (satin stainless steel US32D)
  - 2. H/C Closer. LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)
  - 3. H/C threshold: Zero 564, National Guard 896 or Pemko 2005AS (Aluminum US28)
- G. Hardware Group D - Doors 103A, 107A, 108A, 110A
  - 1. Narrow rim type mortised exit device: Sargent 8300 Series with 700-4 series ET lever control, Von Duprin Series 35L with 06 outside lever or Yale 7200 with matching exterior lever (satin stainless steel US32D)
  - 2. H/C Closer LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)
  - 3. H/C threshold: Zero 564, National Guard 896 or Pemko 2005AS (Aluminum US28)

- H. Hardware Group E - Door 100B, 101A, 102A
  - 1. Entrance/office lockset-lever: Sargent 10G05-LNL, Schlage D50PD-OLY or Yale 5407L-AU (satin stainless steel US32D)
  - 2. H/C Closer LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)
  - 3. Wall stop: Baldwin 4275, Ives 407½ or Hagar 236W (satin chrome US26D)
- I. Hardware Group F-Doors 108B
  - 1. Narrow rim type mortised exit device: Sargent 8300 Series with 700-4 series ET lever control, Von Duprin Series 35L with 06 outside lever or Yale 7200 with matching exterior lever (satin stainless steel US32D)
  - 2. H/G Closer: LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)
- J. Hardware Group G- Door 104A
  - 1. H/C Closer. LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)
  - 2. Wall stop: Baldwin 4275, Ives 407½ or Hagar 236W (satin chrome US26D)
  - 3. Push: Ives 8200, Baldwin 2124 or Hagar 30S - 4" x 16" (satin chrome US26D)
  - 4. Pull: Ives 8302-6, Baldwin 2124/2552 or Hagar 33G/3G - 4" x 16" (satin chrome US26D)
- K. Hardware Group I - Door 105A.
  - 1. Narrow rim type mortised exit device: Sargent 8300 Series with 700-4 series ET lever control, Von Duprin Series 35L with 06 outside lever or Yale 7200 with matching exterior lever (satin stainless steel US32D)
  - 2. Flush bolts: Ives 258, Hagar 282D/283D or Glynn-Johnson FB6 (satin chrome US26D)
  - 3. H/C Closer LCN 4010 Series Smoothee, Norton Series 7500BF or Yale 4400BF (aluminum paint)

## **PART 3 EXECUTION**

### **3.01 INSTALLATION**

- A. Install hardware in accordance with manufacturer's recommendations, using proper templates. Install in standard locations unless detailed otherwise.
- B. Cut thresholds to suite jambs. Attach with stainless steel machine bolts into expansion shields in bed of caulk.



- C. Adjust hardware so that hinges do not bind, doors latch without special effort and there no play between the latch and strike when doors are dosed.
- D. Coordinate with painters for a timely installation. Insure door paint is dry before installing silencers.

END OF SECTION

## **SECTION 08800**

### **GLASS AND GLAZING**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Glass and glazing for hollow metal doors, aluminum doors, windows and storefront work.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 08100: Fiberglass Reinforced Polyester (FRP) Doors.
- B. Section 08400: Entrances and Storefronts.

##### **1.03 REFERENCES**

- A. FS DD-G-1403b - Glass, Plate (Float), Sheet, Figured and Spandrel (Heat Strengthened and Fully Tempered).
- B. FS TT-S-203A - Sealing Compound, Synthetic Rubber Base, Single Component, Chemical Curing for Caulking, Sealing and Glazing in Building Construction
- C. NAAMM SS-1B-68 - Nonskinning Resilient Preformed Compounds - Tapes, Ribbons, Beads with Release Paper.

##### **1.04 SHOP DRAWINGS**

- A Submit in accordance with Section 01300.**

##### **1.05 WARRANTY**

- A. Provide written warranty which will provide for replacing, at no cost to the Owner, hermetically sealed glass units which exhibit interpane dusting or misting within a minimum period of 5 years from the date of Substantial Completion.

#### **PART 2 PRODUCTS**

##### **2.01 GLASS**

- A Safety glass: Clear, tempered safety glass, 1/4" thick, manufactured to meet quality standards established by ASTM C1036, ASTM C1048, CPSC16CFR1201 and ANSI Z97.1.

- A. Insulating tempered glass: 1/4" solar tempered outer pane, 1/4" clear tempered inner pane and 1/2" air space, color to be selected. Units hermetically sealed and manufactured to meet quality standards established by SIGMA, A STM C1036, ASTM C1048, ASTM E774, CPSC 16 CFR 1201 and ANSI Z97.1.
- B. NOT USED

## 2.02 GLAZING COMPOUNDS

- A. Sealant: 1 component sulfide; FS TT-S-230; color selected by Architect; Shore "A" hardness of 15-25.

## 2.03 GLAZING MATERIALS

- A. Glazing tape: Preformed butyl type; NAAMM SS-1B-68, with integral spacing device; 10-15 durometer hardness; paper release; white color.
- B. Setting blocks: Neoprene; 70-90 durometer hardness; 4" long x 3/8" thick x 1/4" ... high.
- C. Spacershims: Neoprene; 50 durometer hardness; 3" long by 3/32" thick by 1/4" high.

## PART 3 EXECUTION

### 3.01 EXTERIOR DRY METHOD (PREFORMED GLAZING CHANNEL)

- A. Clean contact surfaces with solvent and wipe dry.
- B. Cut glazing channel to proper length and install on glass pane. Weld joints by butting channel and dabbing with sealant.
- C. Place setting blocks at 1/4 points.
- D. Rest glass on setting blocks and push against stop with sufficient pressure to ensure full contact and adhesion at perimeter.
- E. Install removable stops, avoid displacement of glazing channel, exert pressure for full continuous contact

### 3.01 CLEANING

- A. After installation, mark glass with "x" by using tape or removable paste.

- B. Immediately remove droppings from finished surfaces. Remove labels after work is complete and inspected.

END OF SECTION

## **SECTION 09260**

### **GYPSUM BOARD SYSTEMS**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Metal framing required for gypsum board.
- B. Blocking.
- C. Acoustical insulation.
- D. Gypsum board.
- E. Vapor barrier.
- F. Acoustical sealant
- G. Taped and sanded joint treatment

##### **1.02 RELATED REQUIREMENTS**

- A. Section 06200: Finish Carpentry.
- B. Section 07210: Thermal Insulation.
- C. Section 08100: Fiberglass Reinforced Polyester (FRP) Doors.
- D. Section 09900: Painting

##### **1.03 QUALITY ASSURANCES**

- A. Perform gypsum board systems work in accordance with requirements of ASTM C754 and GA 216 unless otherwise specified in this Section
- B. Keep copy of GA 216 in field office for duration of project.

##### **1.04 SUBMITTALS**

- A. Submit manufacturer's recommendations for installation of thermal insulation, adhesives and acoustical sealant in accordance with Section 01300.

## 1.05 REFERENCES

- A. G A 216 - Recommended Specifications for the Application and Finishing of Gypsum Board.
- B. ASTM C754 - Installation of Steel Framing Members to Receive Screw-Attached Gypsum Wallboard, Backing Board or Water Resistant Backing Board.
- C. FS HH-I-521D - Insulation Blankets, Thermal Mineral Fiber, for Ambient Temperatures.

## PART 2 PRODUCTS

### 2.01 METAL FRAMING

- A. Provide metal framing materials in accordance with GA 216.
- B. Studs: Screw-type, C-shaped, 25 gage, galvanized steel meeting requirements of ASTM C645, yield strength minimum 33,000 psi.
- C. Runners: Match studs.
- D. Furring members: Screw-type, hat shaped, 25 gage or screw-type, C shaped, 25 gage.
- E. Channels and hanger wires: GA 216.
- F. Fasteners and anchorages: GA 216.

### 2.02 METAL FRAMING ACCESSORIES

- A. Adjustable furring brackets.
- B. Insulation as specified under Section 07210.
- C. Control joints: Back to back casing beads with 4 mil clear polyethylene air seal.
- D. Blocking: 2" thick treated wood.

### 2.03 GYPSUM BOARD

- A. Provide gypsum board materials in accordance with recommendations of GA 216.
- B. Standard gypsum board: 5/8" thick, maximum permissible lengths; ends square cut, tapered and bevelled edges.

- C. Moisture resistant gypsum board (wet walls): 5/8" thick; maximum permissible length; ends square cut, tapered edges.
- D. See Drawings for locations and thickness required.

#### 2.04 GYPSUM BOARD ACCESSORIES

- A. Provide gypsum board accessories in accordance with GA 216.
- B. Corner beads: Metal.
- C. Exposed plastic trim: Vinyl
- D. Reinforcing tape, joint compound, adhesive, water and fasteners: GA 216.

#### 2.05 ACOUSTICAL ACCESSORIES

- A. Acoustical sealant Type recommended for use in conjunction with gypsum board.

### **PART 3 EXECUTION**

#### 3.01 METAL FRAMING ERECTION-GENERAL

- A. Erect metal framing in accordance with ASTM C754.
- B. Install members true to lines and levels to provide surface flatness with maximum variation of 1/8" in 10' in any direction.

#### 3.02 METAL STUD ERECTION

- A. Metal studs: 24" on centers.
- B. Heights: As shown on the Drawings.
- C. Door opening framing: Install double studs at door frame jambs. Install runners on each side of opening at frame height between jamb studs and adjacent studs.
- D. Blocking: Nail wood blocking to studs. Bolt or screw steel channels to studs. Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, toilet accessories, railings, hardware, etc.
- E. Coordinate installation of frames, anchors, blocking, electrical and mechanical work which is to be placed in or behind partition framing. Allow such items to be installed after framing is complete.

### 3.03 GYPSUM BOARD INSTALLATION

- A. Install gypsum board in accordance with GA 216.
- B. Erect single layer standard gypsum board in direction most practical and economical, with ends and edges occurring over firm bearing.
- C. Use screws when fastening gypsum board to metal furring or framing.
- D. Treat cut edges and holes in moisture resistant gypsum board with sealant
- E. Place control joints to be consistent with lines of building spaces and in consistent pattern, and as directed by Architect.
- F. Place comer beads at external comers. Use longest practical lengths. Place edge trim where gypsum boards abuts dissimilar materials.
- G. Tape, fill and sand exposed joints, edges, comers, openings and fixings, to produce surfaces ready to receive surface finishes. Feather coats onto adjoining surfaces so that camber is maximum 1/32".
- H. Remove and re-do defective work.

### 3.04 ACOUSTICAL ACCESSORIES INSTALLATION

- A. Place acoustical insulation in partitions tight within spaces, around cut openings, behind and around electrical and mechanical items within or behind partitions and tight to items passing through partitions.
- B. Erect resilient channel at 24" on centers maximum Make joints occur over framing members.
- C. Place acoustical sealant within partitions in accordance with manufacturer's recommendations. Install acoustical sealant at gypsum board perimeter at penetrations by conduit, pipe, ductwork and rough-in boxes.

END OF SECTION



## **SECTION 09310**

### **CERAMIC TILE**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Ceramic tile floor, wall and base.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 03300: Cast-In-Place Concrete.
- B. Section 06100: Rough Carpentry.
- C. Section 09260: Gypsum Board Systems.

##### **1.03 REFERENCES**

- A. ANSI A108.5 - Ceramic Tile Installed in Dry-Set Portland Cement Mortar on Latex Portland Cement Mortar.
- B. TCA 137.1 - Recommended Standard Specifications for Ceramic Tile.
- C. Tile Council of America - Handbook for Ceramic Tile Installation.

##### **1.04 SUBMITTALS**

- A. Submit product data, static coefficient of friction (ASTM C1028, modified) test, master grade certificate and color samples in accordance with Section 01300.

##### **1.05 ENVIRONMENTAL REQUIREMENTS**

- A. Provide sufficient heat and ventilation in areas where work of this Section is being performed, so as to allow ceramic tile to properly set. Take all precautionary measures necessary to ensure that excessive temperature changes do not occur.

#### **PART 2 PRODUCTS**

##### **2.01 MATERIALS FOR FLOORS AND WALLS**

- A. Ceramic floor tile: 2" x 2" x ¼" size; square edges; smooth surface; unglazed; ceramic porcelain tile manufactured by American Olean Tile Co. or Dal-Tile Corp. Supply complete with matching coved base, Master-Trim Series MT-6 (cove top) and MT-6A (for wall tile).

- B. Glazed wall tiles: 4 ¼" x 4 ¼" glazed wall tile meeting ANSI 137.1. Use wainscot top, in and out comers, jambs and other necessary trim.
- C. Tile shall be standard grade with color selected from color range 1 and 2.
- D. Marble threshold: Grade A white, beveled honed Italian marble.

## 2.02 SETTING MATERIALS

- A. Setting materials and grout shall be in conformance with the recommendations of the Handbook for Ceramic Tile Installation as published by the Tile Council of America, Inc.
- B. Materials, standards and installation shall be in accordance with the following Handbook Method Numbers in the spaces indicated:
- C. Walls: W-243.
- D. Floors: F-122 (waterproof membrane).
- E. Dry set mortar L & M Floor Mix, Upco Tile Mate or H. B. Fuller Lifetime Cement Set (Sanded).
- F. Floor Grout L & M Acid-R Grout, Upco Hydroment Ceramic Tile Grout or H. B. Fuller TEC Joint Filler.
- G. Wall Grout: L & M Dry Tile Grout, Upco Tile Mate Dry Tile Grout or H. B. Fuller Sno-Brite Dry Tile Grout.
- H. Latex Liquid: L & M Surco-Crete (mortar) and Flexible Corout Additive (grout), LaticreteNo. 4237 (mortar) and No. 3701 (grout) or H. B. Fuller TEC Crete (mortar) and Tile Bond (grout).

## PART 3 EXECUTION

### 2.01 INSTALLATION

- A. Prior to installing floor tile, ensure surfaces are level, with maximum variation of 1/8" in 10' (1/480), and are steel trowled. Wall tile to be 1/8" in 8'.
- B. Ensure surfaces are clean and well cured.

- C. Do not commence until surface conditions are within tolerances required for proper installation.
- D. Place tile in accordance with patterns on Room Finish Schedule. Carefully plan tile layouts. Ensure pattern is uninterrupted from one wall and/or floor surface to the next. Center all walls and floors for uniform cut
- E. Neatly cut around fixtures and drains. Accurately form comers, base, intersections and returns.
- F. Ensure tile joints are uniform in width, subject to normal variance in tolerance allowed in tile size. Ensure joints are watertight, without voids, cracks, excess mortar or grout
- G. Sound tile after setting. Remove and replace hollow sounding units.
- H. Keep control joints free of mortar or grout
- I. Follow grout manufacturer's recommendations for grouting.
- J. Completed installation to be free of broken, damaged or faulty tile.
- K. Remove grout haze, observing grout manufacturer's recommendations as to the use of acid and chemical cleaners.
- L. Rinse tilework thoroughly with clean water before and after using recommended chemical cleaners.
- M. Polish surface of tilework with a soft cloth.

END OF SECTION

**SECTION 09510**  
**ACOUSTICAL CEILINGS**

**PART 1 GENERAL**

**1.01 REQUIREMENTS INCLUDED**

- A. Non-fire rated suspended metal grid systems, complete with wall trim.
- B. Lay-in ceiling tile.

**1.02 RELATED REQUIREMENTS**

- A. Division 15: Air diffusers.
- B. Division 16: Lighting fixtures.

**1.03 REFERENCES**

- A. ASTM A 625 - Single Reduced Black Plate.
- B. ASTM C635 - Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
- C. ASTM C636 - Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

**1.04 ENVIRONMENTAL REQUIREMENTS**

- A. Do not install acoustical ceilings until building is enclosed, sufficient heat is provided, dust generation activities have been terminated and overhead mechanical work is complete, tested and approved.
- B. Permit wet work to dry prior to commencement of installation.
- C. Maintain uniform temperatures from 60-85 degrees F. and humidity of 20-40% prior to, during and after: installation.

**1.05 SUBMITTALS**

- A. Submit product data and samples in accordance with Section 01300.

## **PART2PRODUCTS**

### **2.01 SUSPENSION SYSTEM FOR LAY-IN TILE**

- A. Suspension system: Armstrong Prelude ML Series. Similar products by Donn Corp., National Rolling Mills Corp. or Chicago Metallic Corp. conforming to ASTM C635; medium duty system, will be acceptable.
- B. Grid: 15/16" non-fire rated exposed "T"; all components die cut and interlocking.
- C. Accessories: Splices, edge moldings and hold down clips as required to complete and complement suspended ceiling grid system.
- D. Materials/finish: Commercial quality cold rolled steel with galvanized coating; white enamel finish on exposed surfaces.

### **2.02 ACOUSTICAL CEILING**

- A. Acoustical tiles: Armstrong Fine Fissured Ceramaguard No. 608, 24" x 48" x 5/8", NCR 55, CAC 40. Light reflectance .84.
- B. Similar acoustical tile systems by Gold Bond Building Products, Owens-Corning Corp. or Conwed will be acceptable.

### **2.03 MISCELLANEOUS PRODUCTS**

- A. Hanger wires: Galvanized carbon steel, ASTM A641 quality, of size recommended by grid manufacturer to meet specified performance requirements.

## **PART 3 EXECUTION**

### **INSTALLATION**

- A. Install acoustical ceiling systems in accordance with manufacturer's recommendations to produce finished ceiling true to lines and levels and free from warped, soiled or damaged grid or lay-in tiles.
- B. Install ceiling systems in a manner capable of supporting all superimposed loads, with maximum permissible deflection of 1/360 of span and maximum surface deviation of 1/8" in 10'.
- C. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work. Ensure the layout of hangers and carrying channels are located to accommodate fittings and units of equipment which are to be placed after the installation of ceiling grid systems.

- D. Where ducts or other equipment prevents the regular spacing of hangers, reinforce the nearest adjacent hangers and related carrying channels as required to span the required distance.
- E. Supply hangers or inserts for installation to respective section in ample time and with clear instructions for their correct placement. Provide additional hangers and inserts as required.
- F. Hang independently of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of the longitudinal axis or face plane of adjacent members.
- G. Center ceiling systems on room axis leaving equal border pieces.
- H. Do not support fixtures from or on main runners or cross runners if weight of the fixtures causes the total dead load to exceed the deflection capacity. In such cases, support fixture loads by supplementary hangers located within 6" of each corner, or support the fixtures independently.
- I. Do not install fixtures so that main runners and cross runners will be eccentrically loaded. Where fixture installation would produce rotation of runners, provide stabilizer bar.
- J. Install edge molding at intersections of ceiling and vertical surfaces, using maximum lengths, straight, true to line and level. Miter corners. Provide edge molding at junctions with other ceiling finishes.
- K. Fit acoustical lay-in tiles in place, free from damaged edges or other defects detrimental to appearance and function. Fit border units neatly against abutting surfaces.
- L. Install lay-in tiles level, in uniform plane and free from twists, warps and dents.

### 3.02 ADJUSTMENTS

- A. Adjust sags or twists which develop in the ceiling systems and replace any part which is damaged or faulty.

### END OF SECTION

## **SECTION 09650**

### **RESILIENT FLOORING**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Preparation of substrate surfaces.
- B. Application of resilient flooring.
- C. Application of base.
- D. Cleaning of all surfaces and areas of work.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 03300: Cast-In-Place Concrete.

##### **1.03 REFERENCES**

- A. FS L-F-475 - Floor Covering, Vinyl Surface (Tile and Roll), With Backing.
- B. FS SS-W-40 - Wall Base, Rubber and Vinyl Plastic.

##### **1.04 SUBMITTALS**

- A. Submit product data and samples in accordance with Section 01300.
- B. Include full color range of each flooring material

##### **1.05 EXTRA MATERIAL**

- A. Deliver 50 square feet of each color and pattern of floor material for maintenance.
- B. Clearly identify each box/roll.

#### **PART 2 PRODUCTS**

##### **2.01 FLOOR COVERING MATERIAL**

- A. Vinyl-composite tile: Conforming to FS SS-T-312b, type IV, comp. 1; (asbestos free) mottled, 12" x 12" x 1/8" thick; standard grade, colors to be selected by the Architect.

- B. Vinyl base: Conforming to FSSS-W-40A, type II coved 4" high, 1/8" thick including premolded end stops and external comers.

## 2.02 ACCESSORIES, ADHESIVES AND SEALERS

- A. Sub-floor filler: White premix latex, mix with water to produce cementitious paste.
- B. Primer and adhesive: Waterproof; of types recommended by resilient floor manufacturer for specific material.
- C. Sealer and wax: Type recommended by resilient flooring material manufacturer for material type and location.
- D. Edgers: Vinyl edge guards.

## PART 3 EXECUTION

### 3.01 INSPECTION

- A. Ensure floor surfaces are smooth and flat with maximum variation of 1/8" in 10'.
- B. Ensure concrete floors are dry, maximum 7% moisture content, and exhibit negative alkalinity, carbonization or dusting
- C. Maintain minimum 70 degrees F air temperature at flooring installation area for 3 days prior to, during and 24 hours after installation.
- D. Store flooring materials in areas of installation. Allow 3 days for material to reach equal temperature as area.

### 3.02 PREPARATION

- A. Remove sub-floor ridges and bumps. Fill low spots, cracks, joints, holes and other defects with sub-floor filler.
- B. Clean floor and apply, trowel and float filler to leave smooth, flat hard surface. Prohibit traffic until filler is cured.

### 3.03 INSTALLATION-FLOORING

- A. Open floor tile cartons, enough to cover each area, and mix tile to ensure shade variations do not occur within any one area.



- B. Clean substrate. Spread cement evenly in quantity recommended by manufacturer to ensure adhesion over entire area of installation. Spread set. :
- C. Set flooring in place, press with heavy roller to ensure full adhesion.
- D. Lay flooring with joints and seams parallel to building lines to produce symmetrical pattern.
- E. Terminate resilient flooring at centerline of door openings where adjacent floor finish is dissimilar.
- F. Scribe flooring to walls, columns, cabinets, floor outlets and other appurtenances to produce tight joints.
- G. Use edgers where tile terminates with edges exposed.

### 3.01 INSTALLATION-BASE

- A. Fit joints tight and vertical. Maintain minimum measurement of 18" between joints.
- B. Miter internal comers. Use premolded sections for external comers and exposed ends.
- C. Install base on solid backing. Adhere tightly to wall and floor surfaces.
- D. Scribe and fit to door frames and other obstructions.
- E. Install straight and level to variations of plus or minus 1/8" over 10'.

### 3.02 PROTECTION

- A. Prohibit traffic from floor finish for 48 hours.

### 3.03 CLEANING

- A. Remove excess adhesive from floor, base and wall surfaces without damage.
- B. Clean, seal and wax floor and base surfaces in accordance with manufacturer's recommendations.

END OF SECTION

PART 1. GENERAL

1.01 GENERAL REQUIREMENTS

- A. This specification covers preparation of surfaces, performance and completion of painting of all surfaces as required by the drawings and as specified herein.
- B. All Materials delivered to jobsite shall be in original sealed and labeled containers of the paint manufacturer.
- C. Prepare and finish surfaces as indicated on the Architectural Schedule.

1.02 ENVIRONMENTAL CONDITIONS

- A. Coatings shall be applied during good painting weather. Air and surface temperatures shall be within limits pre-scribed by the manufacturer for the coating being applied and work areas shall be reasonably free of airborne dust at the time of application and while coating is drying.

1.03 RELATED REQUIREMENTS

- A. Section 01300: Submittals
- B. Section 04200: Masonry
- C. Section 08110: Metal Doors
- D. Section 08111: Metal Frames

1.04 ENVIRONMENTAL REGULATIONS

- A. All material specified herein meet the current VOC Regulations in effect for the State .

- B. For Potable Water Treatment Plants: Coating materials specified in contact with potable water must be approved in writing by the State of                      Division of Water, and approved in writing by the US EPA (until July 1990) or NSF (after July 1990).
- C. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture contents of surfaces are below the following maximums:
  - 1. Gypsum wallboard                      12%
  - 2. Concrete and concrete block                      12%
  - 3. Wood                      15%
- D. Ensure surface temperatures or the surrounding air temperatures above 40 degrees F before applying finishes. Minimum application temperature for latex paints for interior work is 45 degrees F and 50 degrees F for exterior. Minimum application temperature for varnish is 65 degrees
- E. Provide adequate continuous ventilation and sufficient heating facilities to maintain temperatures above 45 degrees F for 24 hours before, during and 48 hours after application of finishes.

#### 1.05 PROTECTION

- A. Adequately protect other surfaces from paint and damages. Repair damage as a result of inadequate or unsuitable protection.
- B. Furnish sufficient drop cloths, shields and protective equipment to prevent spray or droppings from surfaces not being painted and in particular, surfaces within storage and preparation area.
- C. Place cotton waste cloths and material which may constitute a fire hazard in closed metal containers and remove daily from site.
- D. Remove electrical plates, surface hardware, fittings and fastenings, prior to painting operations. These items are to be carefully stored and replaced on completion of work in each area. Do not use solvent to clean hardware that may remove lacquer finish.

## PART 2. MATERIALS

- A. All materials specified herein are manufactured by the Tnemec Co., Inc., North Kansas City, Missouri, Sherwin-Williams Company, Cleveland, Ohio, and Carboline Company, 350 Hadley Industrial Court, St. Louis, MO 631441599. These products are specified to establish standards of quality and are approved for use on this project.
- B. Equivalent materials of other manufacturers may be substituted on approval of the A/E. Requests for substitution shall include manufacturer's literature for each product giving the name, generic type, descriptive information and evidence of satisfactory past performance. Submittals shall include the following performance data as certified by a qualified testing laboratory:
  - 1. Abrasion - ASTM D 4060, CS-17 Wheel, 1,000 grams load
  - 2. Adhesion - ASTM D 3359 Method B
  - 3. Exterior Exposure - Exposed at 45 degrees facing ocean (Atlantic Sea Coast)
  - 4. Hardness - ASTM D 3363-74
  - 5. Humidity - ASTM D 2247-68
  - 6. Salt Spray (FOG) - ASTM B 117-73
- C. Contractors desiring to use coatings other than those specified shall submit their proposal in writing to the A/E for evaluation prior to ordering alternate coatings. Substitutions which decrease the film thickness, the number of coats applied, change the generic type of coating, or fail to meet the performance criteria of the specified materials will not be approved. Prime and finish coats of all surfaces shall be furnished by the same manufacturer.
- D. Colors, where not specified, shall be as selected by the A/E.

### 2.01 PAINTING SCHEDULE

- A. Steel - Structural, Tanks, Pipes and Equipment 1
    - 1. Exterior, Non-Immersion
- Surface Prep.: SSPC-SP6 Commercial Blast Cleaning.
- 1st Coat: 66-1255 Hi-Build Epoxoline, Macropoxy 646, or Carboguard 893 at 4.0-6.0 mils DFT.

2nd Coat: 73-Color Endura-Shield III, Acrolon 218HS, or Carbothane 133HB at 3.0-5.0 mils DFT.

2. Immersion, Potable Water

Surface Preparation: SSPC-SP10 Near-White Blast Cleaning.

1st Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 3.0 - 5.0 mils DFT.

2nd Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 4.0 - 6.0 mils DFT.

3rd Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 4.0 - 6.0 mils DFT.

3. Interior, Non-Immersion

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.

1st Coat: 66-1255 Hi-Build Epoxoline, Macropoxy 646, or Carboguard 893 at 3.0 - 5.0 mils DFT.

2nd Coat: 66-Color Hi-Build Epoxoline, Macropoxy 646, or Carboguard 890 at 4.0 - 6.0 mils DFT.

4. Miscellaneous Castings, Including Manhole Rings and Covers, Metal Anchorage for Buried Piping, Buried Steel Casing Pipe

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.

One Coat: 46H-413 Hi-Build Tneme-Tar, Targuard, or Bitumastic 300M at 12.0 - 16.0 mils DFT.

5. Factory Primed

Surface Preparation: Surface shall be clean and dry.

Intermediate Coat: 50-330 Poly-Ura-Prime, Macropoxy 646, or Carboguard 888 at 2.0 - 3.0 mils DFT.

Finish Coat: See top coat for exposure. System 3.04 A 1, 2, 4 or 6.

B. Mill Coated Steel Pipe (bituminous coated pipe not allowed)

1. Exterior of Pipe, Non-Immersion

Surface Preparation: Prepare ductile or cast iron surfaces in accordance with NAPF 500-03-04 Abrasive Blast Cleaning with the exception that ALL rust and mold coating be removed. Only tightly adherent annealing oxide may remain. Bituminous coated pipe shall NOT be allowed if field painting is required

1st Coat: 66-1255 Hi-Build Epoxoline, Macropoxy 646, or Carboguard 890 at 4.0-6.0 mils DFT.

2nd Coat: 73-Color Endura-Shield III, Acrolon 218HS, or Carbothane 133HB at 3.0-5.0 mils DFT.

2. Immersion, Potable Water

Surface Preparation: SAME AS ABOVE.

1st Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 3.0 - 5.0 mils DFT.

2nd Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 4.0 - 6.0 mils DFT.

C. Galvanized Steel - Pipe and Miscellaneous Fabrications

1. Exterior, Non-Immersion

Surface Preparation:

Prepare galvanized steel and nonferrous metal surfaces in accordance with SSPC-SP16 Brush-Off Blast Cleaning of Non-Ferrous Metals and the coating manufacturer's instructions.

Test galvanized surfaces for chromate treatments and remove as required by SSPC-SP 16, or other Engineer approved method.

1st Coat: 66-Color Hi-Build Epoxoline, Macropoxy 646, or Carboguard 890 at 4.0-6.0 mils DFT.

2nd Coat: 73-Color Endura-Shield III, Acrolon 218HS, or Carbothane 133HB at 3.0-5.0 mils DFT.

2. Interior, Non-Immersion

Surface Preparation: Same as above

One Coat: 66-Color Hi-Build Epoxoline, Macropoxy 646, Carboguard 890 at 4.0 - 6.0 mils DFT.

D. Concrete, Dense Masonry

1. Exterior, Non-Immersion

Surface Preparation: Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

1st Coat: Series 156-Color Enviro-Crete, Loxon XP, or Flexxide Elastomer at 6.0 - 8.0 mils DFT.

2nd Coat: Series 156-Color Enviro-Crete, Loxon XP, or Flexxide Elastomer at 6.0 - 8.0 mils DFT.

2. Immersion Potable Water

Surface Preparation: Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

Filler Coat: Fill flush all bug holes and voids with Tnemec 63-1500 Filler,

Steel-Seam FT910, or Carboguard A788 and Surface.

1st Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 4.0 - 6.0 mils DFT.

2nd Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 4.0 - 6.0 mils DFT.

3rd Coat: Series 20 Pota-Pox, Macropoxy 646PW, or Carboguard 891 at 4.0 - 6.0 mils DFT.

3. Non-Immersion

Surface Preparation: Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

Filler Coat: Fill flush all bug holes and voids with Tnemec 63-1500 Filler, Steel-Seam FT910, or Carboguard A788 and Surface.

1st Coat: Series 113HB, Pro-Industrial Waterborne Catalyzed Epoxy, Sanitile 255 at 2.5 - 4.0 mils per coat.

2nd Coat: Series 113HB, Pro-Industrial Waterborne Catalyzed Epoxy, Sanitile 255 at 2.5 - 4.0 mils per coat.

E. Porous Masonry

1. Exterior

Surface Preparation: Surface shall be clean and dry. !

1st Coat: Series 156-Color Enviro-Crete, Loxon XP, or Flexxide Elastomer at 6.0 - 8.0 mils DFT.:

2nd Coat: Series 156-Color Enviro-Crete, Loxon XP, or Flexxide Elastomer at 6.0 - 8.0 mils DFT.

2. Interior

Surface Preparation: Surface shall be clean and dry.

1st Coat: Series 130-6602 Enviro-Fill, Cement-Plex 875, or Sanitile 100.

2nd Coat: Series 113HB, Pro-Industrial Waterborne Catalyzed Epoxy, Sanitile 255 at 2.5 - 4.0 mils per coat.

3rd Coat: Series 113HB, Pro-Industrial Waterborne Catalyzed Epoxy, Sanitile 255 at 2.5 - 4.0 mils per coat.

F. Concrete Floors (Finish: epoxy - satin)

Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

1st Coat: Series 66, Macropoxy 646, or Carboguard 890 at 3.0-5.0 mils DFT.

2nd Coat: Series 66, Macropoxy 646, or Carboguard 890 at 4.0-6.0 mils DFT. Uniformly broadcast 50 mesh dry silica sand while still wet.

G. Concrete Structures



1. Below Grade

Surface Preparation: Prepare concrete surfaces in accordance with manufacturer's instructions, SSPC-SP 13/NACE 6, and ICRI 310.2.

One Coat: 46H-413 Hi-Build Tneme-Tar, Targuard, or Bitumastic 300M at 12.0 -16.0 mils DFT.

H. Drywall or Wood (Finish: paint - semi-gloss)

Requires a primer: Series 151-1051 Elasto-Grip FC, PrepRite ProBlock Interior/Exterior Latex Primer/Sealer, or Sanitile 120

1st coat: Series 1029, Sher-Cryl, or Carbocrylic 3350 at 2.5 - 4.0 mils DFT.

2nd coat: Series 1029, Sher-Cryl, or Carbocrylic 3350 at 2.5 - 4.0 mils DFT.

I. Insulated Pipe and PVC Pipe

1. Interior

Surface Preparation: Surface shall be clean and dry.

1st Coat: 6-Color Tneme-Cryl, Sher-Cryl, or Carbocrylic 3350 at 2.0 - 3.0 mils DFT.

2nd Coat: 6-Color Tneme-Cryl, Sher-Cryl, or Carbocrylic 3350 at 2.0 - 3.0 mils DFT.

J. Non-Ferrous Metals

1. Interior

Surface Preparation: SSPC-SP1 Solvent Cleaning.

One Coat: 66-Color Hi-Build Epoxoline, Macropoxy 646, or Carboguard 890 at 4.0 - 6.0 mils DFT.

2. Exterior

Surface Preparation: SSPC-SP1 Solvent Cleaning.

1st Coat: 66-Color Hi-Build Epoxoline, Macropoxy 646, or Carboguard 890 at 4.0-6.0 mils DFT.

2nd Coat: 73-Color Endura-Shield III, Acrolon 218HS, or Carbothane 133HB at 3.0-5.0 mils DFT.

### PART 3. EXECUTION

#### 3.01 INSPECTION

- A. Thoroughly examine surfaces scheduled to be painted prior to commencement of work. Report in writing to Architect, any condition that may potentially affect proper application. Do not commence until such defects have been corrected.
- B. Correct defects and deficiencies in surfaces which may adversely affect work of this section.

#### 3.02 APPLICATION

- A. Materials shall be mixed, thinned and applied according to the manufacturer's printed instructions and in accordance with AWWA D 102.
- B. Apply each coat at proper consistency,
- C. Each coat of paint is to be slightly darker than preceding coat unless otherwise directed by the Architect.
- D. Sand lightly between coats to achieve required finish.
- E. Do not apply finishes on surfaces that are not sufficiently dry.
- F. Allow each coat of finish to dry before following coat is applied, unless directed otherwise by the manufacturer.
- G. Where clear finishes are required to ensure tint fillers match wood, work well into the grain before set. Wipe excess from the surface. '
- H. Backprime exterior woodwork, which is to receive paint finish, with exterior primer paint.

- I. Backprime interior woodwork, which is to receive paint or enamel finish, with enamel undercoater paint.
- J. Prime top and bottom edges of metal doors with enamel undercoat when they are to be painted.

### 3.03 PREPARATION

- A. Prepare surfaces in accordance with coating system's specifications. Touch up welds, burned and abraded areas with specified primer before applying field coats.
- B. Allow each coat to dry thoroughly before applying next coat.
- C. Finish coats shall be uniform in color and sheen without streaks, laps, runs, sags or missed areas. Primer and finish coats shall be furnished from the same manufacturer to ensure compatibility.
- D. Remove mildew, by scrubbing with solution of Tri-Sodium Phosphate and bleach. Rinse with clean water and allow surface to dry completely.
- E. Remove surface contamination from aluminum surfaces requiring a paint finish by steam, high pressure water or solvent washing. Apply etching primer or acid etch. Apply paint immediately if acid etching.
- F. Remove dirt, powder residue and foreign matter and paint immediately.
- G. Remove contamination from gypsum wallboard surfaces and prime to show defects, if any. Paint after defects have been remedied.
- H. Remove surface contamination and oils from galvanized surfaces and wash with solvent. Apply coat of etching type primer.
- I. Remove surface contamination and oils from zinc coated surfaces and prepare for painting in accordance with metal manufacturer's recommendations.
- J. Remove dirt, loose mortar, scale, powder and other foreign matter from concrete and concrete block surfaces which are to be painted or to receive a clear sealer. Remove oil and grease with a solution of Tri-Sodium Phosphate, rinse well and allow to thoroughly dry.
- K. Remove stains from concrete and concrete block surfaces caused by weathering or corroding metals with a solution of Sodium Metasilicate after being thoroughly wetted with water. Allow to thoroughly dry.

- L. Remove grease, rust, scale, dirt and dust from steel and Iron surfaces. Where heavy coatings of scale are evident, remove by wire brushing, sandblasting or any other necessary method. Ensure steel surfaces are satisfactory before painting.
- M. Clean unprimed steel surfaces by washing with solvent. Apply a treatment of Phosphoric Acid solution, ensuring weld joints, bolts and nuts are similarly cleaned. Prime surfaces to indicate defects, if any. Paint after defects have been remedied.
- N. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather out edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces.
- O. Wipe off dust and grit from miscellaneous wood items and millwork prior to priming. Spot coat knots, pitch streaks and sappy sections with sealer. Fill nail holes and cracks after primer has dried and sand between coats. Back prime interior and exterior woodwork.

#### 3.04 MECHANICAL

- A. Refer to mechanical and electrical sections with respect to painting and finishing requirements, color coding, identification banding of equipment, ducting, piping and conduit.
- B. Paint interior surfaces of air ducts, convectors and baseboard heating cabinets that are visible through grilles and louvers with one (1) coat of flat black paint, to limit of sight line. Paint dampers exposed immediately behind louvers, grilles, convectors and baseboard cabinets to match face panels.
- C. Paint exposed conduit and electrical equipment occurring in finished areas. Color and texture to match adjacent surfaces.

#### 3.05 ACCEPTANCE OF WORK

- A. All surface preparation and repairs shall be approved by the A/E before primer is applied.
- B. Request acceptance of each coat before applying next coat.
- C. Correct work that is not acceptable and request re-inspection.

### 3.06 CLEANING

- A. As work proceeds and upon completion, promptly remove paint where spilled, splashed or spattered.
- B. During progress of work and upon completion, promptly remove paint where spilled, splashed or spattered.
- C. Upon completion of work, leave premises neat and clean, to the satisfaction of the A/E.
- D. Remove and dispose of all rubbish or other unsightly material in a legal manner, leaving the premises in a clean condition.

END OF SECTION

## **SECTION 10156**

### **PHENOLIC TOILET PARTITIONS**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Headrail braced phenolic toilet partitions and screens.
- B. Attachment hardware.
- C. Factory accessory reinforcing and cutouts.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 09260: Gypsum Board Systems.
- B. Section 10800: Toilet and Bath Accessories.

##### **1.03 SHOP DRAWINGS AND PRODUCT DATA**

- A. Submit shop drawings and product data in accordance with Section 01300.
- B. Indicate partition layouts, swing of doors, elevations, anchorage and mounting details, components, hardware, finishes, available colors and relevant dimensions.
- C. Provide color chart indicating manufacturer's standard colors.

#### **PART 2 PRODUCTS**

##### **2.01 ACCEPTABLE MANUFACTURERS**

- A. Boberick Washroom Equipment, Inc., DuraLine Series 1180. I
- B. Sanymetal Academy Sanyphenolic.
- C. The Mills Company Designer Option Series 3000.
- D. Substitutions: Items of same function and performance are acceptable.

##### **2.02 MATERIALS**

- A. Toilet partitions shall be furnished with manufacturer's standard pilasters, wall posts, doors, panels and hardware required for a complete installation. Two colors will be select«! from manufacturer's standard color chart.

- B. All partition hardware shall be stainless steel or non-ferrous chrome plated.

### **PART 3 EXECUTION**

#### **3.01 INSTALLATION**

- A. Examine site conditions.
- B. Provide 1/2" space between wall and panels and between wall and end pilasters.
- C. Attach panel brackets securely to walls using appropriate anchor devices.
- D. Attach panels and pilasters to brackets with through bolts and nuts with tamperproof beads. Locate headrail joints at pilaster center lines.

END OF SECTION

**SECTION 10441**  
**EXTERIOR SIGNAGE**

**PART 1 GENERAL**

1.01 REQUIREMENTS INCLUDED

- A. Fabrication and installation of exterior signage.
- B. Attachment hardware.

1.02 RELATED REQUIREMENTS

- A. Section 04200: Masonry.

1.03 SUBMITTALS

- A. Submit 1 sample of each substituted letter for Architect's approval, if requested.
- B. Submit shop drawings in accordance with Section 01300.
- C. Indicate layout, attachment and letter style.

**PART 2 PRODUCTS**

2.01 ACCEPTABLE MANUFACTURERS

- A. Andeco Industries Coip.
- B. The Southwell Company.
- C. Products of equal function and performance are acceptable.

2.02 BUILDING MOUNTED LETTERS

- A. Letters shall be minimum 1/4" thick by 16" high cast aluminum with baked enamel finish, color selected from standard range.
- B. Style of letters shall be Helvetica Medium.

2.03 FASTENERS

- A. Fasteners shall be threaded bolts welded to the back side of the letter. Provide aluminum sleeves for insertion into holes drilled into masonry. Provide stand off sleeve.



## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install letters in strict accordance with manufacturer's printed instructions.
- B. Provide template at the job site to assure proper location of mounting holes.

**END OF SECTION**

## **SECTION 10500**

### **LOCKERS**

#### **PART I GENERAL**

##### **1.01 REQUIREMENTS INCLUDED**

- A. Metal locker body and hinged door.
- B. Treated wood base.
- C. Metal sloping top.
- D. Hooks, latches and hardware.
- E. Attachment hardware.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 09260: Gypsum Board Systems.

##### **1.03 REFERENCES**

- A. ASTM A446 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Structural Quality.

##### **1.04 SHOP DRAWINGS AND PRODUCT DATA**

- A. Submit shop drawings, manufacturer's data and installation instructions in accordance with Section 01300.
- B. Clearly indicate general construction, configurations, joining methods, layout, accessories, colors, finish, numbering, fastening methods and installation details

##### **1.05 PROTECTION**

- A. Protect locker finishes and adjacent surfaces and materials from damage or marring during installation.

## **PART2 PRODUCTS**

### **20.1 ACCEPTABLE MANUFACTURERS**

- A. Acceptable manufacturers:
  - 1. Interior Steel Equipment Co.
  - 2. PENCO Products, Inc.
  - 3. Republic Storage Systems.
  - 4. Superior.

### **2.02 TYPE AND SIZE**

- A. Single Tier, 15" wide x 21" deep x 72" high.

### **2.03 MATERIALS**

- A. Sheet steel: ASTM A446, commercial grade, stretcher leveled, galvanized, of the following minimum gages:
  - 1. Body and shelf: 24.
  - 2. Base, top and trim: 22.
  - 3. Doors: 20.
  - 4. Door inner faces: 24.
  - 5. Doorframes: 16.
  - 6. Hinges: 14.
- B. Locker fittings: Recessed locking handle, coat hooks, rod, shelf, door numbers and rubber bumpers.

### **2.04 FABRICATION**

- A. Bodies: Formed and flanged with stiffener bibs, electrically spot welded.
- B. Doors: Channel reinforced top and bottom, inner face with stiffening ribs, inner and outer face welded with three welded hinges for full height doors, 2 hinges for other doors, recessed locking handle. Bolt hinges to door frame. Recess and install number plate.
- C. Door Frame: Formed channel shape, welded and ground flush, welded to body.
- D. Provide ventilation openings at top and bottom of each locker.
- E. Furnish edges smooth.

- F. Prepare locking handle for padlock.

## 2.05 FINISHING

- A. Clean, degrease and neutralize, follow with a prime coat and two finish coats of baked enamel.
- B. Paint lockers in two contrasting colors.
- C. Colors to be manufacturer's standard range.

## **PART 3 EXECUTION**

### 3.01 INSTALLATION

- A. Install lockers secure, plumb, square and in line.
- B. Anchor lockers to wall with anchor devices.
- C. Bolt adjoining locker units together to provide a rigid installation.
- D. Install metal end panels and filler panels to close off openings.
- E. Provide and install sloped metal top with end fillers.

END OF SECTION

**SECTION 10800**

**TOILET AND BATH ACCESSORIES**

**PART 1 GENERAL**

**1.01 REQUIREMENTS INCLUDED**

- A. Toilet and bath accessories listed herein.
- B. Rough-in frames applied for other sections.
- C. Attachment hardware.

**1.02 RELATED REQUIREMENTS**

- A. Section 06100: Rough Carpentry.
- B. Section 09260: Gypsum Board Systems.
- C. Section 10156: Phenolic Toilet Partitions.

**1.03 REFERENCES**

- A. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip.
- B. ASTM A366 - Cold-Rolled Carbon Steel Sheets, Commercial Quality.

**1.04 SUBMITTALS**

- A. Submit 1 sample of each substituted accessory for Architect's approval, if requested.
- B. Submit shop drawings in accordance with Section 01300.

**1.05 DELIVERY, STORAGE AND HANDLING**

- A. Do not deliver accessories to site until rooms in which they are to be installed are ready to receive them.
- B. Pack accessories individually in a manner to protect accessory and its finish.

**1.06 PROTECTION**

**A. Protect adjacent or adjoining finished surfaces and work from damage during installation.**

**PART 2 PRODUCTS**

**2.01 MATERIALS**

- A. Sheet steel: ASTM A366, cold rolled stretcher leveled; 1.25 oz./sq. ft. galvanized coating.
- B. Stainless steel sheet: ASTM A167, commercial grade, 22 gage.
- C. Adhesive: Epoxy type contact cement.
- D. Fasteners, Screws and Bolts: Hot dip galvanized.
- E. Expansion shields: Fiber, lead or rubber as recommended by accessory manufacturer for component substrate.

**2.02 FINISHES**

- A. Chrome/nickel plating: Satin finish
- B. Stainless steel: Polished finish.

**2.03 FABRICATION**

- A. Weld and grind smooth joints of fabricated components.
- B. Form exposed surfaces from 1 sheet of stock, free of joints.
- C. Provide steel anchor plates and anchor components for installation on building finishes.
- D. Form surfaces flat without distortion. Maintain flat surfaces without scratches or dents.
- E. Back paint components where contact is made with building finishes to prevent electrolysis.
- F. Hot dip galvanize ferrous metal anchors and fastening devices.

- G. Shop assemble components and package complete with anchors and fittings.

**2.04 SCHEDULE OF ACCESSORIES**

- A. Accessories shall be as manufactured by Bobrick, American Specialties or approved equal. The following numbers are Bobrick:
  - A1 - Mirror B-165, 18" x 34" channel frame
  - A2 - Paper towel dispenser. B-262, surface.
  - A3 - Trash Receptacle: B-2250, 13 gal.
  - A4 - Tissue dispenser B-27460.
  - A5 - Hook: B-222.
  - A6 - Shower curtain/rod: B-6047, 18 gage rod and B-204-1/2, hooks and curtain.

**PART 3 EXECUTION**

**PREPARATION**

- A. Deliver inserts and rough-in frames to job site at appropriate time for building-in. Provide templates and rough-in measurements as required.
- B. Before starting work, notify Architect in writing of any conflicts detrimental to installation or operation of units.

**INSTALLATION**

- A. Install fixtures, accessories and items in accordance with manufacturer's printed instructions.
- B. Install true, plumb and level, securely and rigidly anchored to substrate.
- C. See Drawings for locations of all items.

**END OF SECTION**

### PART 1. GENERAL

- 1.1 Furnish, install and place in satisfactory operation a static in-line mixer to serve as a functional rapid mix system for the mixing of chemicals in the raw water influent stream of the water treatment facility. Install the static in-line mixer at the location shown on the project drawings.
- 1.2 Submittal data shall be furnished to the A/E in accordance with Section 01305 - Equipment Submittals, of these specifications. The provisions of Paragraphs 2.1 and 2.2 of Section 01305 shall apply.
- 1.3 Refer to other sections of these specifications for items of work affecting the static inline mixer. Coordinate this work with that specified in other sections for timely completion.

### PART 2. PRODUCTS

- 2.1 There shall be furnished and installed one (1) static in-line mixer at the location shown on the project drawings. The mixer shall meet the following specifications:
  - A. The mixer shall be suitable for mixing up to 2100 gallons per minute of raw water with liquid alum, polymer, caustic, and chlorine. There shall be a total of six (6) V\* chemical feed taps on the mixer. Stainless steel injection quills shall be provided for all chemical feed ports by the static mixer manufacturer.
  - B. The mixer shall be eighteen inches in diameter and shall have a laying length of approximately 72 inches. At the maximum flowrate of 2100 GPM the pressure loss through the mixer shall not exceed one (1) psi.
  - C. The mixer shall have a ductile iron housing with three (3) 304 stainless steel mixing elements. The mixer shall have flanged connections drilled to 125 # ANSI standards, flat face. The exterior of the mixer shall be primed with TNEMEC 201255. Final painting shall be in accordance with Section 09900 - Painting, of these specifications.
  - D. The mixer shall be Koflo or an approved equal.



### PART 3. EXECUTION

- 3.1 Install the static in-line mixer in strict accordance with the manufacturer's recommendations.

END OF SECTION

**VERTICAL TURBINE PUMPS**

**PART 1 GENERAL**

**1.01 RELATED DOCUMENTS:**

- A. The general provisions of the contract, including both General and Supplementary Conditions and General Requirements (if any) apply to the work specified in this Section.

**1.02 DESCRIPTION OF WORK:**

- A. The required pumps and other related equipment, and the extent of the required work is shown on the drawings. The Description of Work shall be as outlined below but shall be interpreted to include all of the materials, equipment, and labor/work as may be required to construct facilities in accordance with the general descriptions provided for this project, and as shown on the applicable drawings in the Plans. The work required for this project shall include (but is not limited to) the following:
  - 1. Installation of new vertical turbine pumps in the specific locations shown on the Plans or specified herein, variable frequency drives, complete electrical control system, wet well and support structure', and all other appurtenances to the extent indicated on the Plans or specified elsewhere herein
  - 2. Piping required for each pump, including all valves and fittings, specialized equipment and/or accessories, gauges, and force main piping as specified herein or as shown on the Plans
  - 3. Electrical work required for the pumping installation, to include the main electrical service with meter and disconnect, station lighting as shown on the Plans, and all conduit and wiring that may be required to provide power to the station and equipment required
  - 4. Appurtenances (metal fencing, etc...) as required
  - 5. Site grading, gravel, construction of access roadway(s), concrete aprons, handrails and grating, or other finish items that are indicated on the Plans or are specified herein, and all other finish work as required to complete the installation of the station
- B. The Contractor shall furnish and install, as shown on the Plans and specified herein, vertical turbine pumps and related accessories for Finished Water High Service and Backwash applications. The principal items of equipment to be provided include complete pump assemblies (each consisting of a discharge head, column, line shafting, and vertical turbine bowl assembly) as specified herein, drive motors, steel sole plates, air release valves, pressure gauges, all valves and piping of the sizes specified herein or indicated on the Plans, variable speed drives and any other equipment that might be specified herein, or as may be required to constitute a complete and functional water pumping system.
- C. Work shall include the installation of various pumps complying with the performance and mechanical requirements that are set forth herein.

Pumping facilities shall be constructed as shown on the Plans, and all equipment provided shall be new and unused.

- D. All equipment comprising the various turbine pumps must be supplied by the same pump manufacturer. This shall include, but is not limited to, pump bowls, impellers, column and assembly hardware, line shafting and bearings, discharge heads, drive motors, and any other equipment specified herein. Well drillers, pump distributors, or fabrication shops will not be allowed to furnish any equipment constructed in a local fabrication shop. All equipment furnished under this section shall be fabricated and assembled in full conformance with the drawings, Specifications, Engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.
  - 1. Pumps provided for this project will conform to the detailed performance and construction requirements as outlined under Section 2.01 below.
  - 2. All equipment provided for this project, including but not limited to the pump, piping, valves, electrical equipment, and all other materials used to construct the specified facilities, shall be new and unused.
  - 3. Pumping equipment shall be manufactured in the United States.
  - 4. Pump manufacturer shall be certified to ISO 9001 standards for the design and manufacture of vertical turbine pumps. Equipment shall be produced in a production facility that recognizes its impact on the environment and has demonstrated a commitment to the minimizing that impact by achieving ISO 14001 certification.

**1.03 QUALITY ASSURANCE:**

- A. Materials, physical and chemical characteristics of the components and all testing requirements shall conform to current AWWA, ANSI, HI, and ASTM standards.
- B. Electrical equipment shall be manufactured in strict accordance with the most recent requirements of the National Electric Code.

**1.04 SUBMITTALS AND O&M MANUALS:**

- A. Ten (10) sets of manufacturer's certified drawings and descriptive data showing the principal dimensions, construction details, and materials of construction for all components of the pump shall be provided for the review and approval of the Engineer. Additional copies will be provided as required to provided file copies for the contractor, site inspector, city personnel, etc... The contractor shall coordinate the number of copies required for this project with the Engineer and the supplier.
  - 1. Submittal data shall reflect the exact equipment to be provided for the pump proposed. Complete fabrication and assembly drawings as well as detailed Specifications and data covering materials, parts, devices and accessories forming a part of the equipment shall be furnished and shall be submitted in accordance with the submittals

section. The data and Specifications for each pumping unit shall include but not be limited to the following:

- Name of manufacturer proposed
- Type and model of equipment offered
- Outline dimensional drawings for the proposed pumps
- Design rotative speed
- Number of stages proposed
- Type of bowl bearings
- Unit performance curve for design condition
- Variable speed performance curves in 100 RPM increments
- Type of line shaft bearings proposed
- Size of shafting proposed
- Size of pump column proposed
- Size of discharge flange
- Outside diameter of pump bowls
- Component weights
- Complete data on shop painting
- Maximum overall dimensions
- Total weight, including motor

2. Generic or non-specific submittals will not be considered acceptable. The submittals provided shall include complete performance curves that show capacity versus head, NPSH required, efficiency, and BHP plotted scales" consistent with the performance requirements. Calculated variable speed curves shall also be included with the submittals, showing the reduced pump performance at 100 RPM speed reductions until the minimum specified flow<sup>1</sup> is reached.

- B. The pump manufacturer shall deliver not less than six (6) copies of the support literature (installation, operation and maintenance manuals) to the Engineer for the pump and all related equipment specified herein. As with the submittals, additional copies will be provided as required to provided file copies for other involved parties, and the contractor shall coordinate the number of copies required for this project with the Engineer and the supplier. Installation of the pump and appurtenances will be performed in strict accordance with any/all written instructions provided by the equipment manufacturer.

1. The operation and maintenance manuals shall be in addition to instructions or parts lists packed with or attached to the equipment when delivered to the job site. Operation and maintenance manuals shall include the following:
  - Equipment function, normal operating characteristics, and limiting conditions
  - Detailed assembly, installation, alignment, adjustment, and checkout instructions

- Operating instructions for startup, routine, and normal operation, as well as regulation and control, shutdown and emergency conditions
  - Lubrication and maintenance instructions, including quantities - Guide to troubleshooting
  - Parts lists and predicted life of parts subject to wear
  - Outline, cross-section, and assembly drawings, Engineering data, and wiring diagrams as may be required
  - Test data and performance curves, where applicable.
2. If electrical control panels are provided as part of a turbine pump package, electrical schematic diagram of the control system shall also be provided, prepared in accordance with NMTBA and JIC standards. The schematics shall illustrate (to the extent of authorized field repair) pump motor branch, control and/or alarm system circuits, and all interconnections between these circuits. Wire numbers shall be clearly indicated on all schematic diagrams.
- a. Schematics for individual components not normally repairable by the operating personnel need not be included, and the details for such components shall be provided in lieu of overall system schematics.
  - b. Partial schematics of the components, block diagrams, or simplified schematics will not be provided in lieu of overall system schematic diagrams.
3. Printed copies of the O&M manuals shall be provided in the quantities noted above. Two additional copies shall be provided on compact disk, readable using Adobe Acrobat.

**1.05 MANUFACTURER'S ABILITY TO PERFORM.**

- A. Upon request from the Owner or Engineer, the pump manufacturer shall provide adequate proof of financial security relative to performance and his ability to meet delivery schedules. Also, if requested by the Owner or Engineer, the manufacturer shall provide evidence of facilities, equipment, and expertise as may be required to produce the equipment specified herein. Such evidence shall be demonstrated solely by a visit to the pump manufacturer's facility by the Engineer or the Owner.

**1.06 APPROVED MANUFACTURERS:**

- A. These specifications are based on equipment manufactured by Grundfos Water Utilities (Peerless Vertical Turbine Pumps), Inc., for the purpose of establishing a minimum standard of quality that is considered acceptable for use on this project. Equipment offered by other manufacturers will be considered as equal, but only if adequate data and supporting information is provided to verify that the proposed alternate

meets the performance and construction requirements established herein.

- B. Manufacturers desiring to be considered shall submit the following information for approval of each pump, as a minimum:
- Name of manufacturer, type, and model number proposed
  - Design rotating speed
  - Number of stages
  - Size of shafting and pump column
  - Size of suction and discharge connections
  - Wet/operating weight of the complete pump and motor assembly
  - Overall dimensional information and certified dimensional drawing
  - Performance curves showing pump capacity versus head, NPSH required, efficiency, and BHP plotted (scale consistent with performance criteria) for both the hydraulic/bowl performance and corrected performance reflecting internal losses |
  - Variable speed performance curves for the specified design speed and 100 RPM reductions in speed down to 67% of the design speed
  - Model-specific CAD drawings for the proposed equipment based on design criteria and elevations (outline, cross-section, and assembly drawings, full engineering data, and wiring diagrams shall also be included)
  - Manufacturer's verification that all materials proposed comply with these specifications
- C. The Engineer will review all submissions for alternate equipment. The decision of the Engineer regarding acceptability of equipment proposed will be final.

## PART 2 PRODUCTS

### 2.01 PUMP PERFORMANCE REQUIREMENTS:

- A. Pumping units shall be designed for the performance and design requirements as required, at maximum speed unless otherwise noted. Pump curves for equipment that will be operated utilizing variable frequency drives shall be continuously rising towards shutoff and shall be free from dips and valleys from the design point to the shutoff head. The shutoff head shall be at least 115% of the head that occurs at the design point. For design and rating purposes, the water to be pumped shall be assumed to have a temperature of 70°F.
- B. Each vertical turbine pump provided for this project shall be designed and ruggedly constructed to provide maximum economy and performance during operation, and shall be capable of meeting the following criteria:
1. Finished Water High Service Pumps:

Design Condition (Per Pump): 1500 GPM @ 402' TDH (85.2 %  
*bowl eff. Minimum*)  
 Minimum Shutoff Head: 528' (minimum)  
 NPSHR at Design: 22.7' (maximum)  
 Maximum Pump Speed: 1770 RPM ;  
 Maximum Motor HP: 200 HP  
 Number of Stages: 6 (minimum)  
 Column/Shaft Size: 12" (flanged) w/1-1/4" shaft  
 Pump Model: Grundfos Peerless Model GL12ME/HC  
 Quantity Required: two (2)

2. Backwash Pumps:

Design Condition: 2610 GPM @41'TDH (86.0% *bowl eff.*)  
 Minimum Shutoff Head: 62' (minimum) ;  
 NPSHR at Design: 6.T (maximum)  
 Maximum Pump Speed: 705 RPM  
 Maximum Motor HP: 40 HP  
 Number of Stages: 2 (minimum)  
 Column/Shaft Size: 12" (flanged) w/1 1/4" shaft  
 Pump Model: Grundfos Peerless Model  
 Quantity Required: two (2)

- B. Pumps shall conform to the peak efficiency noted at the specified design conditions, without exception.
- C. The total dynamic head values indicated above includes estimated losses for the pump discharge head and column friction as well as shaft horsepower losses. The equipment supplier shall include calculated losses for the pump to be provided with the required submittal data. Failure to provide this data shall constitute basis for rejection of the equipment by the Engineer.
- D. Finished Water High Service and Backwash pumps are expected to run at varying speeds, utilizing variable frequency drives. The pump manufacturer shall provide variable speed curves for all pumps proposed showing the performance of the equipment at 100 RPM reductions in operating speed. The pump manufacturer shall adjust the final impeller diameter to compensate for variations between the nominal and full load motor speed. Performance criteria may vary slightly due to increase or decrease of the actual/final impeller diameter required to achieve the specified design condition at the rated full-load motor speed.

2.02 PUMP CONSTRUCTION:

- A. Discharge head shall be of cast iron surface discharge with 125#/150# ANSI dimension discharge flange and shall support the motor, column, shafting, and pump bowl assembly. The discharge head shall be mounted on a fabricated steel sole plate which shall be anchored to a concrete pad over the clearwell. The bottom surface of the head shall be machined smooth. A tapped drain line connection shall be provided for the removal of the excess water to a drain, plus taps for pressure gages shall be provided.

- B. A cast iron stuffing box shall be provided with a bronze removable stuffing box bushing, 316 stainless steel split gland, T-bolts with stainless steel clips and brass nuts. Stuffing box shall utilize a minimum of five synthetic (Garlock 8913 or equal) packing rings, compressed around the pump shaft and lubricated by the pumped water.
- C. A two piece top shaft shall be threaded and coupled just above the stuffing box (on column setting 50 feet or less).
- D. Lifting lugs shall be integral with the discharge head and be capable of supporting the entire weight of the pump assembly unless a landing plate is furnished which supports the column and bowl assembly weight.
- E. Column pipe shall be furnished in interchangeable sections not over 10 feet in length and shall be connected with flanges. The actual column lengths shall be determined by the pump manufacturer, calculated so that the bearing spacing intervals shall not allow operation within +/-20% of the first critical speed. The friction loss in the column shall not exceed 5 feet per 100 feet of column, based on the rated capacity of the pump. The weight and size of the column shall be no less than required in AWWA Spec E101-1. The line shafting shall be AISI 416 stainless steel of ample size, a minimum of 1.00" diameter, to operate the pump without distortion or vibration.
- F. Carbon steel shafting with glued on, sprayed, or set screw mounted sleeves shall not be acceptable in Open Line Shaft, OLS service. In abrasive service or in deep wells, Enclosed Line Shaft (ELS) design shall be used when lubricated by oil or if clean flushing water is available.
- G. OLS lines shafts shall be furnished in interchangeable sections not more than 10 feet in length and shall be coupled with AISI 410 stainless steel couplings. The column assembly shall have bronze drop in bearing retainers retained by the butted pipe ends or column flanges. For larger column sizes, weld-in fabricated steel bearing retainers will be utilized. Bearing retainers of cast iron shall not be acceptable. Each bearing retainer shall contain an easily removable, water-lubricated, cutlass rubber bearing designed for vertical turbine pump service.
- H. The pump bowls shall be of close grained cast iron, having a minimum tensile strength of 30,000 pounds per square inch, free from blow holes, sand holes, and all other faults. Bowls shall be accurately machined and fitted to close dimensions. Bowls are to be coated inside with a smooth vitreous enamel to reduce friction losses; corrosion and sand wear in the water passages and thus give better efficiency. Each intermediate bowl shall be constructed by using both a bronze bearing and a neoprene bearing to support the impeller shaft, thus giving the longest possible life, based on the widest range of pump conditions. All bowl fasteners shall be of stainless steel.



- I. Bowls shall be fitted with a resilient neoprene ring, reinforced with an imbedded steel core, installed in the bowl directly below the impeller skirt. This lateral bowl wear ring is to reduce the wear of the impeller skirt and maintain the as new capacity and efficiency by periodic adjustment of the lateral clearance from top shaft nut at the top of the motor.
- J. The impellers shall be of the enclosed type, only made of 316L stainless steel, and accurately machined, finished, and balanced. Semi open impeller designs are strictly prohibited. Impellers shall be securely fastened to the impeller shaft with steel taper lock bushing or split rings and keys for larger bowls. The impeller shaft shall be of stainless steel of not less than 12% chrome. The impeller shaft shall be supported by a combination of water lubricated, fluted rubber and bronze bearings.
- K. The suction bell/manifold shall incorporate an integrally cast bearing housing with an SAE 660 bronze bearing and cast iron manifold plug. The suction bell bearings shall be permanently packed with grease (unless in abrasive service then a clean water flush is required).
- L. Sand collars of bronze shall be provided for protecting both the suction bell/manifold bearings and the top bowl bearings from abrasives in the water being pumped which could settle when the pump is idle.
- M. The suction bell/manifold shall be fitted with a clip-on basket type strainer or vortex suppressor of 316 stainless steel. The openings in the strainer shall be of proper size to exclude anything large enough to clog the impeller. The open area of the strainer shall not be less than four times the impeller eye area. All mounting hardware for clipping the strainer to the suction shall be 300 series stainless steel.

## 2.03 PUMP MOTORS:

- A. The motor shall be NEMA standard design B, Vertical Hollow Shaft, high thrust, WP-1 enclosure, 1800 RPM, squirrel cage induction full voltage type starting, driven by VFD's, powered by an electrical service rated at 460 volts, 60 hertz, 3 phase. Each motor shall be capable of driving the pump under all head conditions without exceeding the rated capacity of the motor. Motor shall have class B insulation, 1.15 service factor load. Motor shall be supplied with a non-reverse ratchet. Motor shall conform to IEEE and NEMA, standards. Motor design shall be premium efficiency style.
- B. The motor thrust bearing shall be designed to carry the hydraulic thrust plus the weight of the shaft and the impellers. The thrust bearing life expectancy shall have a five year average rating based on 24 hours per day usage. The motor shall be capable of carrying momentary up thrust equal to approximately 30% of the total down thrust. Bearings shall be oil or grease lubricated as per manufacture's standard design.

- C. Each motor shall be provided with a corrosion-resistant nameplate giving the name of the manufacturer, horsepower, voltage, frequency, speed, efficiency and current for unit at full load.
- D. Any motors provided for this project that are intended for operation with variable frequency drives shall be specifically designed as such by the manufacturer. These motors shall be labeled as “inverter duty”. The use of standard motors that are “rated” by the manufacturer as capable of VFD operation will not be considered. All motors shall bear a tag or name plate/label, separate from the data plate, that indicates that they are an inverter duty design.

**2.04 ADDITIONAL REQUIREMENTS:**

- A. The pumps shall be factory coated prior to assembly and shipment to the job site. All wetted surfaces, including the bowl assembly OD, column ID/OD, discharge head ID, and sole plate top shall be factory coated prior to assembly and shipment to the job site. Coating shall be compatible with and approved for use with potable water and shall be provided with the minimum dry thickness (DFT) as noted below.
  - 1. Prior to coating, all surfaces shall receive a commercial blast meeting the requirements of SSPC-SP10, and shall immediately receive a potable epoxy primer. The finish shall be Carboline Carboguard #891 high-build epoxy or NSF-approved equivalent by Tnemec or Koppers. Coatings shall be factory- applied in not less than two (2) coats of 4-6 mils DFT each, for a minimum total finish of 10-12 mils DFT, before final assembly.
  - 2. Assembly bolting for flanged bowl casing connections will be ASTM A269 304 stainless steel, as specified herein. The exterior surfaces of the pump discharge head (only those portions exposed after installation) shall be primed and painted with one coat of standard machinery enamel prior to shipment from the factory, for finish painting in the field by the Contractor in accordance with the appropriate section of the Specifications.
  - 3. Drive motors will receive one shop coat of primer and finish enamel at the manufacturer's facility prior to shipment. Finish painting shall be provided in the field by the Contractor, in accordance with the Specifications. Coating shall be applied at the manufacturer's facility prior to shipment.
  - 4. The Contractor shall be responsible for field finish painting of all equipment and accessories, as outlined elsewhere in these Specifications or directed by the Engineer. Finish color of all pumping equipment and related piping, etc... shall be as selected by the Engineer or the Owner.

- B. Each bowl assembly shall be non-witness tested at the factory for capacity, power requirement, and efficiency at minimum head, rated head, shutoff head or point of discontinuity, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall conform to the requirements and recommendations of the Hydraulic Institute Standards.
1. If the pump fails to operate properly or fails to meet the specified conditions or requirements during witnessed shop testing, the pump manufacturer shall modify the pumping unit and perform additional testing to verify performance as specified above.
  2. The pump manufacturer shall submit complete pump test reports, including test arrangement, instrumentation calibration data, test procedures, and test data in curve format.
  3. Certified test reports shall be submitted to the Engineer for review and approval prior to shipment. No equipment shall ship to the job site until the Engineer has reviewed and approved the test results.
- C. All variable speed pumps provided for this project shall be shall be designed to safely operate free of resonant frequencies. To ensure this, the pump manufacturer shall perform a reed critical frequency analysis of the pump head, motor stand (if applicable) and electric motor shall be performed. The analysis shall be performed by a licensed Professional Engineer using finite element analysis (FEA) software.
1. The results of the analysis shall be provided in the form of a written report provided as a part of the required equipment submittal package and shall demonstrate that the natural frequencies and mode shapes of the pump and motor have been considered in the design of the discharge head and certifying that the critical frequency is at least 20% above or below the operating range.
  2. The analysis shall demonstrate that the equipment provided for this project will not produce objectionable vibration during operation. If the harmonic analysis shows that the pump passes through a critical frequency between 50-100% of full speed, the manufacturer shall modify the design and/or construction of the discharge heads to change the harmonic frequency of the units provided so that vibration is-avoided. For this reason, variable speed pumps shall only utilize fabricated steel discharge heads, so that they can be modified, gusseted, reinforced, lengthened, etc... as required. The harmonic analysis protocol and results shall be included in the submittal data provided for each pump, for review and approval by the Engineer.

3.01 EXECUTION

A. EXAMINATION

1. Verify that location is ready to receive equipment.
2. Verify that the building environment can be maintained within the service conditions required by the manufacturer of the VFD.

B. INSTALLATION

1. Installation shall be in compliance with all manufacturer requirements, instructions and drawings.

C. START-UP SERVICE

1. At a minimum, the start-up service shall include:
  1. Perform pre-Power Check
  2. Megger Motor Resistances: Phase-to-Phase and Phase-to-Ground
  3. Verify system grounding per manufacturer's specifications
  4. Verify power and signal grounds
  5. Check connections
  6. Check environment
2. Drive Power-up and Commissioning:
  1. Measure Incoming Power Phase-to-Phase and Phase-to-Ground
  2. Measure DC Bus Voltage
  3. Measure AC Current Unloaded and Loaded
  4. Measure Output Voltage Phase-to-Phase and Phase-to-Ground
  5. Verify input reference signal
3. All measurements shall be recorded.
4. Drive shall be tuned for system operation.
5. Drive parameter listing shall be provided.

**D. TRAINING**

1. Manufacturer to provide a quantity of ( ) ( )-hour sessions of on-site instruction.
2. The instruction shall include the operational and maintenance requirements of the variable frequency drive.
3. The basis of the training shall be the variable frequency drive, the engineered drawings and the user manual. At a minimum, the training shall:
  1. Review the engineered drawings identifying the components shown on the drawings.
  2. Review starting / stopping and speed control options for the controller.
  3. Review operation of the Human Interface Module for programming and monitoring of the variable frequency drive.
  4. Review the maintenance requirements of the variable frequency drive.

K. Review safety concerns with operating the variable frequency drive.

**3.02 SUPPORTS AND THRUST BLOCKS:**

- A. All piping associated with the vertical turbine pump shall be properly supported in accordance with good commercial practice. Concrete piers, restraining rods, and other equipment or materials shall be installed as shown on the Plans.

**3.03 SPARE PARTS AND EQUIPMENT**

- A. After successful startup of the specified pumps, the contractor shall be required to provide the following spare parts and equipment to the Owner for use during normal operation and/or maintenance:
  1. Three (3) complete sets of graphited packing for each pump

**3.04 MANUFACTURER'S WARRANTY**

- A. The pump manufacturers shall warrant the equipment supplied for this project to be of the highest quality construction, free of defects in material and workmanship, for a period of one year from the date of project acceptance or beneficial use by the Owner.

- B. It is not intended that the respective equipment manufacturers assume liability for consequential damages or contingent liabilities that may arise from the failure of any product or parts thereof to operate properly, however caused; whether by or resulting from, or arising out of, any defects in design or manufacture, delays in delivery, replacements or otherwise.
- C. The equipment warranty shall not apply to those items that are normally consumed in service, such as light bulbs, grease, oil, packing, gaskets, O-rings, etc...
- D. Components failing to perform as specified by the Engineer, or as represented by the manufacturer, or proven defective in service during the warranty period, will be replaced, repaired, or satisfactorily modified by the manufacturer without cost of parts or labor to the Owner.
- E. The equipment warranty shall become effective upon the acceptance by the Owner or Engineer, or sixty (60) days after installation, or ninety (90) days after shipment from the factory, whichever occurs first.

END OF SECTION

# Sample Supply Pumps For Finished Water Analyzers and Turbidimeters

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## PART 1. GENERAL

### 1.1 WORK INCLUDED

- A. Finished Water Analyzers and Turbidimeters Supply Pumps with required piping and accessories. All discharge suction lines shall consist of PVC piping anchored and strapped with stainless steel components as not to corrode.

### 1.2 RELATED WORK

- A. Division 16: Electrical
- B. Section 09910: Painting

## PART 2. PRODUCTS

### 2.1 WATER SUPPLY PUMP

- A. Furnish and install nine (9) heavy-duty close-coupled horizontal centrifugal pumps and motors. The pump and motor shall be mounted on a single ANSI #416 stainless steel shaft.

#### Required Supply Pumps:

- One (1) for Finished Water pH Analyzer
- One (1) for Finished Water Chlorine Residual and Fluoride Analyzer
- One (1) for the Pre-Filtration Chlorine Residual Analyzer
- Four (4)/one (1) each for the four filter's Finished/Filtered Water Turbidimeters
- One (1) Combined Finished/Filtered Water Turbidimeter
- One (1) spare pump to be stored at the Water treatment Plant as a backup if one of the inline pumps should fail.
- Provide spare seals, suction connections, discharge connections and
- pump rebuild parts.

The pumps shall be cast-bronze fitted and shall be equipped with a mechanical seal. The pump and motor shall be equipped with a cast iron base plate which shall be suitable for direct mounting with not more than four (4) bolts.

The pumps shall be capable of delivering three (3) gallons per minute of water (Sp. G. 1.0) against a total dynamic head of 30 feet of water. The flow rate shall be adjustable base on the adjustment of the pump's speed.

Two (2) of the pumps shall be capable of withdrawing water from the clearwell and supplying sample water for the two finished water analyzers (one for finished water pH and one for both finished water chlorine and fluoride residual). One (1) of the pumps shall be capable of withdrawing water from the clarified water trough/splitter box prior to entering the filters and supplying water to the pre-filtration chlorine residual analyzer. Five (5) of the pumps shall be capable of withdrawing sample water from the filter's finished water discharge piping and discharge to the turbidimeters.

The pumps shall be capable of providing a minimum of 25-feet of suction lift. The pumps shall be installed at the general location of the analyzers and as approved by the A/E as to supply sample water. The motor shall be 1/4 HP, 1800 RPM, single phase, 60 cycle, 120 volts, full voltage starting. The contractor shall verify pump characteristics with the required supply rate needed for the analyzers and the turbidimeters.

## 2.2 VALVES

- A. Provide isolating shutoff valves and check valves as recommended by the pump supplier.

## PART 3. EXECUTION

- A. As shown on the plans and in accordance with the manufacturer's recommendations.

END OF SECTION



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**ACTIFLO® CARB SYSTEM**  
**FULL SCALE SPECIFICATIONS**

**Krüger**

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## PART 1 - GENERAL

### 1.01 DESCRIPTION OF THE SYSTEM

- A. The ACTIFLO® CARB Process is a high performance compact clarification system using microsand enhanced flocculation and settling combined with PAC recirculation for TOC and taste and odor removal. PAC is dosed into the raw water line which enters a PAC contact tank with mixer. The water then flows over a weir into the coagulation tank. A coagulant is added at the overflow. A coagulation tank high-speed mixer provides coagulant dispersion and begins floc formation. The coagulated water then enters a second tank called the maturation tank, where the microsand and flocculant aid polymer is added. The microsand provides a large contact area for floc attachment and acts as a ballast, thereby accelerating the settling of the flocs. The flocculant aid polymer binds the destabilized suspended solids to the microsand particles by forming polymer bridges. In the maturation tank, the high efficiency mixing zone created by the use of a draft tube allows the microsand/sludge flocs agglomerate and grow into high-density flocs known as microsand ballasted flocs. In the fourth tank, the settling tank, the microsand ballasted flocs settle quickly to the bottom of the tank. The efficiency of settling is further increased by the use of the lamella tubes. The PAC/sludge/microsand mixture is collected at the bottom of the settling tank, below the lamella tubes. This mixture is then continuously pumped to hydrocyclones where the sludge is separated from the microsand by the centrifugal forces generated in the hydrocyclone. The recovered microsand is continuously recycled to the maturation tank, and the separated PAC sludge flows to a PAC return box where a portion of the PAC is wasted continually to allow the PAC age to remain constant. The majority of the PAC is returned by gravity to the PAC tank through an opening in the bottom of the box.

### 1.02 OPERATING CONDITIONS

Site Reference	Greenup, KY
Type of application	Drinking Water
Type of Installation	(X) Indoor ( ) Outdoor
Number of trains	2
Design Flow per train (continuous operation)	1.5 MGD
Design Surface Loading Rate in settling zone	10 gpm/sf
Maximum Daily Flow per train (hydraulic capacity)	2.25 MGD
Number of recirculation lines per train	1
Flow per recirculation line	90 gpm

### 1.03 DESIGN REQUIREMENTS

- A. The ACTIFLO® process shall be capable of thorough coagulant mixing, microsand and polymer injection and mixing, floc maturation, settling, and removal. Final water clarification will take place via lamella settling tubes. Microsand is separated from the sludge/microsand mixture via continuous recirculation through the hydrocyclone(s). The microsand is continuously re-injected into the ACTIFLO® Process and the sludge is continuously discharged.
- B. The system shall be capable of initiating operation and reaching 65% of specified process performance within 1 to 2 hydraulic retention times when operated at design flow rate.
- C. The system shall be capable of continuously operating at surface loading rates of 10 gpm/sf at design flow rate for drinking water types of treatment.
- D. Only those processes making use of microsand ballasted flocculation, operating in the manner described above, will be considered.

#### 1.04 ACTIFLO® SUPPLIER SCOPE OF WORK

- A. Krüger, Inc. is responsible for process design and equipment sizing, selection and procurement required for the ACTIFLO® system. The system will be designed and supplied in accordance with the Specifications as described herein. Krüger, Inc. scope of work does not include any engineering, selection, procurement, installation, or operation of any equipment, materials or other services not specifically defined in this Specification.
- B. Engineering will be in accordance with the project Plans and Specifications and those applicable national codes, standards and / or regulations in effect at the time of this project, except as otherwise noted. Krüger, Inc. will provide all necessary design, installation and operating information for equipment within its stated scope of supply. Krüger, Inc. is not responsible for the design, selection, installation, operation or maintenance of any materials, equipment or services supplied by others.
- C. Krüger, Inc. will provide process engineering and design support for the cast-in-place system as follows:
  - 1. Dimensional Layout
  - 2. Installation Details
  - 3. Start-Up and Operation Instructions
  - 4. Electrical and Controls Diagram(s)
  - 5. Parts and Spare Parts List(s)
  - 6. Operation and Maintenance Manual

D. Field Services

Krüger, Inc. will provide the services necessary to start-up, test, and operate the system as follows:

1. Advice during installation
2. Equipment check-out and start-up assistance
3. Operator training
4. Follow-up site visits

## 1.05 QUALITY ASSURANCE

- A. American National Standards Institute (ANSI)
- B. National Electric Manufacturer's Association (NEMA)
- C. National Electric Code (NEC)
- D. Standard Methods for the Examination of Water and Wastewater
- E. Institute of Electrical and Electronics Engineers (IEEE)

## 1.06 SUBMITTALS

- A. The Supplier shall furnish to the Contractor for review, six copies of each submittal. The term "submittal" as used herein shall be understood to include installation drawings, catalog sheets and data sheets. Unless otherwise required, said submittals shall be submitted to the Contractor, at a time sufficiently early to allow review of same by the Contractor. The Contractor shall furnish the Engineer the submittals in compliance with the Project Specifications.
- B. Copies of all materials required establishing compliance with the specifications shall be submitted in accordance with the provisions of the contract documents. Submittals shall include at least the following:
  1. Installation drawings showing important details of construction, dimensions, and anchor bolt locations.
  2. Descriptive literature, bulletins, and/or catalogs of the equipment.
  3. Data on the characteristics, features, and performance of the equipment.
  4. Electrical Schematics, panel layouts, field wiring diagrams, instrumentation sheets, and product data sheets for all electrical equipment being supplied by the ACTIFLO® manufacturer.
  5. The weight of all equipment including the weight of the single largest item.
  6. A complete bill of materials for all equipment.
  7. Complete motor drive data.

## 1.07 OPERATION AND MAINTENANCE

- A. Operation and maintenance manuals shall be furnished. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, and other information that is required to instruct operation and maintenance personnel unfamiliar with such equipment.
- B. A factory trained representative with complete knowledge of the proper system operation and maintenance shall be provided to instruct representatives of the Owner and the Engineer on proper operation and maintenance of the system and equipment. The instruction shall be conducted in conjunction with the inspection of installation and start-up assistance as provided under Part 3. If there are difficulties in operation of equipment due to contractor's work, additional services shall be provided by supplier at standard supplier rates. The Supplier shall be provided with a minimum of 3-weeks notice prior to the date personnel are requested to be on site.

## 1.08 PRODUCT HANDLING

- A. Equipment, including spares will be shipped by the ACTIFLO® Supplier or the Supplier's vendor when the equipment is ready and available for shipment. The Contractor will be responsible for receiving, unloading and properly storing the equipment in accordance with Supplier's instructions. Promptly upon the arrival of any equipment components at the job site or first shipping destination, the Contractor will prepare a Supplier's receiving report and submit a copy thereof to the Supplier. The receiving report is to note equipment receipt and all evidence of damage in transit, if any. Confirmation of inspection will be no later than 10 days after receipt of delivery.
- B. Finished iron or steel surfaces not required to be painted, such as flange faces, shall be properly protected to prevent rust, corrosion and damage.
- C. Each box or package shall be properly marked to show its net weight in addition to its contents.

## 1.09 WARRANTY

- A. Subject to the following sentence, Seller warrants to Buyer that the Equipment shall materially conform to the description in Seller's Documentation and shall be free from defects in material and workmanship. The foregoing warranty shall not apply to any Equipment that is specified or otherwise demanded by Buyer and is not manufactured or selected by Seller, as to which (i) Seller hereby assigns to Buyer, to the extent assignable, any warranties made to Seller and (ii) Seller shall have no other liability to Buyer under warranty, tort or any other legal theory. If Buyer gives Seller prompt written notice of breach of this warranty within 18 months from delivery or 1 year from acceptance, whichever occurs first (the "Warranty Period"), Seller shall, at its sole option and as Buyer's sole remedy, repair or replace the subject parts or refund the purchase price therefore. If Seller determines that any claimed breach is not, in fact, covered by this warranty, Buyer shall pay Seller its then customary charges for any repair or replacement made by Seller. Seller's warranty is conditioned on Buyer's (a) operating and maintaining the Equipment in accordance

with Seller's instructions, (b) not making any unauthorized repairs or alterations, and (c) not being in default of any payment obligation to Seller. Seller's warranty does not cover damage caused by chemical action or abrasive material, misuse or improper installation (unless installed by Seller). THE WARRANTIES SET FORTH IN THIS SECTION ARE SELLER'S SOLE AND EXCLUSIVE WARRANTIES AND NOTWITHSTANDING ANYTHING ELSE TO THE CONTRARY, SELLER SHALL NOT BE LIABLE FOR ANY CONSEQUENTIAL, INCIDENTAL, SPECIAL, PUNITIVE OR OTHER INDIRECT DAMAGES, AND SELLER'S TOTAL LIABILITY ARISING AT ANY TIME FROM THE SALE OR USE OF THE EQUIPMENT SHALL NOT EXCEED THE PURCHASE PRICE PAID FOR THE EQUIPMENT. THESE LIMITATIONS APPLY WHETHER THE LIABILITY IS BASED ON CONTRACT, TORT, STRICT LIABILITY OR ANY OTHER THEORY. SELLER MAKES NO OTHER WARRANTIES OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR PURPOSE.

## 1.10 PATENTS

- A. The Supplier shall assume all costs of patent fees or licenses for equipment or processes which it provides, and shall indemnify and defend the Owner and their agents from damages, judgments, claims and expenses arising from license fees or third party claimed infringements or any letters of patent or patent right, or because of royalty or fee for the use of any equipment or process which it provides; and the price stipulated for all such patent fees, licenses, or other costs pertaining thereto.



## PART 2 – PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Krüger of Cary, NC.
- B. The Supplier system must:
  - a. Meet specification Section 1.02 OPERATING CONDITIONS;
  - b. Have a minimal of 15 years of experience in providing ballasted flocculation systems, and have at least 20 installations;
  - c. Be approved by Kentucky Division of Water;
  - d. Have proved the technologies ability to meet the project performance goals through on site bench scale or pilot testing prior to the project's advertisement date.

### 2.02 GENERAL

- A. The equipment covered by these Specifications is intended to be standard process equipment of proven ability as manufactured by reputable concerns having long experience in the production of such equipment. The equipment furnished shall be designed, constructed and installed in accordance with the best practices and methods and shall operate satisfactorily when installed as shown on Kruger's drawings.
- B. All parts shall be so designed and proportioned as to have liberal strength and stiffness and to be especially adapted for the work to be done. Ample room and facilities shall be provided for inspection, repairs and adjustment.
- C. The nameplate ratings for the motors shall not be exceeded, nor shall the design service factor be reduced when its piece of equipment is operating at any point on its characteristic curve.
- D. The location, size, and type of all piping shall be as shown on the Drawings, or as required by the equipment, if size not shown.

### 2.03 PAC, COAGULATION, AND MATURATION MIXERS

- A. Each mixer assembly shall consist of a heavy-duty speed reducer, premium efficient electric motor, baseplate, agitator shaft, and mixing impellers. Mechanical details of each component shall be as follows:
  - 1. The mixer gear drive must be built in accordance with the current AGMA Standards. The AGMA calculated drive HP rating shall be stamped on the drive nameplate. Drive housings shall be of high quality close grained cast iron, or fabricated steel, stress relieved and reinforced, and shall be provided with lifting lugs. Each unit shall be provided with an integral or separate baseplate and shall have a minimum 12" pedestal base for ease of assembly of the agitator shaft and to facilitate draining of the oil from the gear drive.

2. Gearing must be vertical parallel shaft all helical gears or helical spiral bevel to ensure the highest efficiency coupled with the convenience of mounting and maintenance (worm gearing is not acceptable). Helical gears shall be a minimum AGMA Quality 10 per AGMA standard 390.03. Spiral/bevel sets shall be a minimum AGMA Quality 8, matched and lapped. The gears shall be lubricated from a common oil bath. The full load operating noise levels of the mixer drives shall not exceed 85 dBA at 3 feet from any part of the drive assembly.
3. The mixer gear drive shall be designed with an output shaft system suitable for the loadings imposed by the specific duty. The drive's minimum AGMA service factor shall be 1.5 and based upon motor nameplate horsepower. The service factor shall be based on AGMA Standard 6010-F97 for 24 hour per day moderate shock application. Service factors based on uniform load and motor bhp will not be accepted. Agitator gear drive coupled to impeller shaft must be designed, manufactured, and tested by the mixer supplier.
4. 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 50,000 hours when operating at full motor nameplate horsepower at design speed.
5. Each drive must have an effective lubrication of rotating elements without leakage down the output shaft. Output shaft bearings may be grease lubricated. Output shaft bearing seals shall be dry-well type.
6. The electric motor drivers shall have a 1.15 service factor and TEFC/TENV enclosure with class F insulation and class B temperature rise above 40 deg C ambient. The motors shall be squirrel cage induction motors for operation on 3 phase, 60 hertz, 230/460 volt current with synchronous speed of 1800 RPM or less. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. Maturation mixer motors are to be used with AC inverters that shall meet NEMA MG1, part 31 for variable torque, 10:1 turndown operation. The motor shall be connected to the input shaft with a rigid or flexible coupling and shall be pilot mounted with a NEMA C face flange. Integral mounted motors shall be accepted. IEC or other non-NEMA motor flanges will not be accepted. All motors shall be designed constructed and tested in accordance with applicable IEEE, NEA, and ANSI, standards.
7. The lower mixer shaft shall be connected to the upper, or drive output shaft, by means of a rigid flanged or integral coupling.
8. The agitator shaft shall be of 304 stainless steel construction or other approved material as recommended by the mixer manufacturer. The shaft shall be designed such that the combined (Mohr's circle) maximum shear stress shall not exceed 9,000 psi under maximum operating loads for stainless steel. It shall be of overhung design for use in complete coverage (liquid levels at least one impeller diameter above the impeller height). The use of underwater steady bearings is not permitted. The PAC and coagulation tank agitators shafts shall have extended keyways to allow the impeller to be placed 0.75D to 1.0D off of the

tank bottom.

9. Mixer impellers shall be a low-shear, axial-flow, hydrofoil-type impeller, and the maturation tank mixer impeller shall be a high-solidity, draft tube-type impeller. Impellers shall be constructed of 304 stainless steel or other approved material as recommended by the mixer manufacturer. Impellers shall be bolted construction and shall be connected to the agitator shaft with an open key for maximum security. The maximum stress in any impeller component shall not exceed 11,000 psi under maximum operating loads.
10. Upon installation each unit shall be run to demonstrate its ability to operate without overloading, jamming, or excessive vibration during normal operation.
11. All non-wetted parts will be shipped with manufacturer's standard factory paint, suitable for use as a finish coat. All touch-up and additional coats are to be applied in the field by the contractor. Wetted parts, of 304 or 316 stainless steel, will not be painted.
12. The mixers shall be as manufactured by STAMO, Philadelphia Mixers, or Lightnin.

## 2.04 MATURATION TANK DRAFT TUBE

- A. A draft tube and mixer assembly shall be provided for the maturation tank for increased mixing efficiency.
  - a. The draft tube shall be constructed of 304L stainless steel, or other approved material, and shall be designed and supplied by the ACTIFLO® Supplier.
  - b. The draft tube support, independent from the means for supporting the Maturation mixer, shall be supported from the tank floor on 304L steel legs.

## 2.05 MICROSAND PUMPS

### A. General

1. Pumps to be provided under this Contract shall have purpose and duties as described in the project specifications and shall comply with the following general specifications unless stated otherwise.
2. The pumps shall be designed so that they:
  - a. Operate at the best possible efficiency over the operating range based on the application and pump model selection.
  - b. Are capable of continuous operation at all times.
  - c. Shall have a continuously falling head/capacity characteristic curve from no flow to maximum flow conditions to ensure satisfactory parallel operation.

3. The supplier shall supply all standard performance curves of the pumps showing head/flowrate, horsepower, efficiency and net positive suction head requirements over the full operating range.
4. A complete arrangement drawing of each pump shall be provided by the supplier showing overall dimensions and stating the weight of the combined pump, motor and base.
5. The impellers shall be statically balanced to ensure freedom from vibration. Shafts and other rotating components shall be statically balanced or machined, depending on pump model.
6. Pumps shall be driven by V-belts and sheaves to obtain the required pump speed. Provision shall be made for adjusting belt tension. A fully enclosed, steel belt guard shall be provided in compliance with OSHA requirements.

**B. Pump Arrangement/Construction**

1. Casings shall be cast iron radially split type, for easy maintenance, fitted with field replaceable abrasion resistant rubber liners pressure molded to the backing plate and secured to the casing externally by heavy-duty studs and nuts. Rubber liners shall extend through casing nozzles to form natural gaskets between flanges and piping. Flanges shall be solid type, flat-face weld neck flanges.
2. The impeller shall be abrasion resistant rubber, pressure molded to a ductile iron/steel support skeleton OR shall be a recessed type (open vane) consisting of rubber-lined construction, depending on the application. Determination of impeller type shall be made by the ACTIFLO® system supplier. Impeller to be screwed to the shaft with heavy duty threads running in opposite direction to the shaft rotation for maximum security.
3. The pump shall be fitted with a flushless mechanical seal. The mechanical seal shall be suitable for sand slurry service. An external seal water flush is not required but a drip pan, with suitable drain piping connection is required.
4. All bearings to be heavy-duty anti-friction type completely enclosed in an oil-lubricated cast iron cartridge assembly or lubricated by grease depending on pump model.
5. All pumps and motors shall be provided with necessary lugs, eyebolts, or other suitable attachments for lifting.
6. The microsand pumps shall include a sub-base which shall provide for ease of pump removal from the field.
7. The electric motor shall be sized to be non-overloading at the design operating point on the pump performance curve with a minimum service factor of 1.15. Motor enclosure shall be TEFC with class F insulation and class B temperature rise above 40 deg C ambient. Motors shall be 3 phase, 60 Hertz, 460-volt power. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. All motors shall

comply with manufacturers standard design, construction and testing procedures as define by applicable IEEE, NEMA, and ANSI standards.

8. Pumps shall be shipped with the manufacturer's standard paint, suitable for use as a finish coat. All touch-up and additional coats are to be applied in the field by the contractor.

C. Manufacturers

1. The microsand pumps shall be manufactured by McLanahan Corp, or approved equal.

## 2.06 SLUDGE/SAND GEAR DRIVE AND SCRAPER ASSEMBLY

A. General

1. The sludge scraper mechanism shall be suitable for installation in the settling tank with a floor slope of 8 degrees. The total load of the scraper mechanism shall be supported from the walkway spanning the top of the settler tank.
2. Each scraper shall comprise a complete assembly including center drive assembly, overload alarm, torque tube, sludge collector arms and necessary anchorage parts.
3. The overall mechanism shall be designed for a torque capacity determined when the full volume of sand in the system is collected at the bottom of the settler.
4. The vertical shaft shall be fabricated of schedule 40 304 stainless steel pipe flanged at its upper end for mounting to the drive unit and attachments at its lower end for the rake arms. The center scraper shall be attached to the center shaft and shall extend into the sludge discharge cone. No submerged steady bearing shall be permitted.
5. The rake arms shall be fabricated of 304 stainless steel and designed to move the solids to the discharge cone.
6. The final output shaft from the gearbox shall be designed to operate with a maximum output speed of 0.50 rpm at full motor speed.
7. The discharge cone scraper shall be fabricated of 304 stainless steel attached directly to the center shaft.

B. Center Drive Mechanism

1. The drive mechanism shall consist of a premium efficient electric motor, a primary hydraulic reduction unit, an intermediate reduction unit (for torque ratings >14,000 ft-lbs), and a final reduction unit.
2. Final Reduction Unit (for torque ratings <14,000 ft-lbs)
  - a. The final gear reduction unit shall have bearings with a B-10 life in excess of 100,000 hours and be AGMA rated for 10,000,000 cycles when operating at the continuous operating torque. The final gear reduction unit shall be of the planetary/spur gear type and shall be permanently grease lubricated.
3. Primary Hydraulic Reduction Unit
  - a. The primary hydraulic reduction unit shall drive the intermediate/final reduction unit. It shall consist of a Parker Hannifin or equal hydraulic gear pump (positive displacement type) driving a Parker Hannifin or equal hydraulic motor. A 3.0 service factor shall be applied to the catalog rating of all commercial hydraulic components.
  - b. The hydraulic motor shall be designed for low speed - high torque operation. A pressure relief valve shall be incorporated to provide additional protection against overload. All hydraulic components shall be enclosed in a steel enclosure that shall serve as the reservoir for the hydraulic fluid. The enclosure shall be capable of holding five gallons of hydraulic fluid. To ensure soft start capabilities drives incorporated chains and or belts shall not be acceptable.
4. Electric Motor
  - a. The electric motor shall be an inverter duty motor for use with a variable frequency drive. Motor enclosure shall be TEFC with class F insulation and class B temperature rise above 40 deg C ambient. Motors shall be 3 phase, 60 Hertz, 460 volt power. Motors shall be premium efficiency type and rated for severe duty. Efficiency shall be determined in accordance with IEEE 112, Test Method B. All motors shall comply with manufacturers standard design, construction and testing procedures as define by applicable IEEE, NEMA, and ANSI standards.
5. Overload Device
  - a. An overload device shall be attached to the primary hydraulic reduction unit and shall be activated by the hydraulic pressure in the primary reduction unit. The device shall have two (2) adjustable pressure switches so that an alarm circuit may be energized when the load on the mechanism approaches overload, and open the motor circuit when an overload occurs. The overload device shall also have a minimum 6" diameter gauge that will indicate the

output torque of the drive in ft.-lbs. To ensure accurate torque readings drives utilizing the movement a gear shall not be acceptable.

C. Support Bridge (not by Kruger)

- a. The entire weight of the scraper drive, shaft, and rake arm assembly shall be supported by the bridge. The bridge shall be constructed of hot-dipped galvanized steel, with aluminum grating and handrails. The grating shall be removable to allow access to the lamella tubes for cleaning. The bridge shall be of sufficient width to allow the operator access past the drive assembly. The bridge shall utilize a bolt-through connection for attachment of the handrails. The bridge shall be anchored by bolt-through connections to the maturation tank covering and the effluent launder wall.
- b. The scraper support bridge shall be structurally designed so as to support a 75 lb/sf live load in addition to the structural load of the equipment itself. This additional live load shall account for the weight of operations personnel on the support bridge.
- c. The scraper bridge shall be constructed of hot dipped galvanized steel beams covered with aluminum grating and handrails.

D. Manufacturer

- a. The sludge drive gearbox shall be manufactured by DBS or ClearStream Environmental, Inc.; the sludge rake assembly shall be assembled by ClearStream Environmental, Inc., or approved equal.

## 2.07 HYDROCYCLONES

- A. The hydrocyclones shall be sized by the ACTIFLO® Supplier. The underflow of the hydrocyclones shall be gravity fed to the maturation tank for reuse of the clean microsand. The overflow of the hydrocyclone shall be sent by gravity flow to the PAC return tank. Materials shall be food-grade urethane.
- B. The hydrocyclone shall require a flush water supply equal to 10% of the hydrocyclone flow. This flush will allow for a greater recovery of sand and will also prevent solids from returning to the system through the underflow. The flush water source may be ACTIFLO settled water or plant service water.
- C. A booster pump (provided by others) shall be utilized to provide the necessary pressure required to carry the flush water to the hydrocyclone.

D. The hydrocyclone shall be the MA type, manufactured by Aquafab, Krebs or approved equal.

## 2.08 LAMELLA SETTLING EQUIPMENT

- A. Equipment shall have an incline at 60 degrees from the horizontal. Equipment shall be sufficiently supported underneath by 304 stainless steel pipe girders anchored to the settler walls.
- B. The total required surface area of lamella equipment in each settling tank shall be equal to the square footage required to produce the design surface loading rate.

## 2.09 EFFLUENT COLLECTION SYSTEM

- A. Clarified water shall be collected by means of square notched collection troughs. Each trough shall discharge to a common effluent launder.
  - 1. Collection troughs shall be rectangular shaped and fabricated from 304 stainless steel. The troughs shall be sized by the ACTIVFLO® Supplier

## ~~2.10 FABRICATED HANGING WALL~~

- ~~A. The Settling Area shall be defined by a fabricated hanging wall. The hanging wall shall act as containment for the lamella settlers and provide support for the collection troughs.~~
  - ~~1. The hanging wall shall consist of a 304 stainless steel frame and HDPE sheet. The wall shall be sized and designed by the ACTIVFLO® Supplier.~~

## ~~2.11 STILLING BAFFLES~~

- ~~A. Stilling baffles shall be utilized at the Maturation Tank weir wall to induce laminar flow.~~
  - ~~1. The Stilling Baffles shall be constructed of 304 stainless steel sheet. The baffles shall be sized and designed by the ACTIVFLO® Supplier.~~

## 2.12 PAC RETURN TANK

- A. The system shall make use of a PAC return tank to be located over the PAC mixing tank. The tank shall receive the hydrocyclone overflow through a flanged opening. The tank materials shall be 304 stainless steel. The tank will contain an overflow weir to allow PAC to be wasted from the system.



- B. The tank shall be sized and designed by the ACTIFLO® supplier.

## 2.13 PAC WASTING PUMP

- A. Two (1 per train) PAC waste pump shall be provided to continually pump PAC from the PAC Return Tank to waste. This will allow the PAC concentration in the ACTIFLO system to remain constant. The pump will be located next to the PAC return box and will pump from the box through a tap at the bottom of the box.
- B. The pump shall be peristaltic type, variable speed drive, 316 SS wetted insert, cast iron housing and rotor, galvanized steel supports.
- C. The pump motor shall be 460V / 3 ph / 60 hz, 1.15 service factor, 1750 rpm, TEFC enclosure. Baldor or equal.
- D. The pump manufacturer shall be Watson Marlow, Periflo, Verder, or equal.

## 2.14 VALVES

- A. PVC Isolation Valves
  - 1. All PVC isolation valves shall be the true-union type ball valve as manufactured by Hayward, Inc. or equal. Valves shall be supplied with socket ends, plastic actuating lever, PVC body, and EPDM O-Rings.
- B. Eccentric Plug Valves
  - 1. For applications with a system pH above 5.0, all eccentric plug valves shall be industrial resilient seated type with ANSI class 125/150 flat face through bolting flanges. Plug valves shall be provided with cast iron wafer type bodies, acrylonitrile-butadiene packing, neoprene resilient seat material, manual lever or hand wheel actuated. Plug valves shall be PEC plug valves as manufactured by DeZurik, or approved equal.
- C. Ball Valves
  - 1. All ball valves shall be industrial type, regular port design with carbon steel body and stainless steel trim. End connections should be NPT, butt weld, or flanged per ANSI standard, and as specified on the plans. All welded end valves shall be of the 3-Piece design for ease of maintenance. Flanged end valves may be of two

piece or unibody design. Instrument isolation valves shall be threaded end unibody design. All valve seats shall be reinforced Teflon. Valves should be supplied with lever operators unless otherwise specified. Valves shall be as manufactured by Velan or equal.

## 1.15 PLC CONTROL PANEL(S)

- A. The PLC based control panel(s) will be supplied to monitor and control the ACTIFLO® process. All panels are required to be installed **INDOORS ONLY**. Each control panel, will be completely assembled, tested and programmed for the required functionality. Each U.L. labeled panel will be designed according to the scope of supply listed in the ACTIFLO® Scope of Supply. The quantity of panels will be based on the number of ACTIFLO® trains in the design. There shall be one control panel per two trains for even numbered train configurations, and for odd numbered train configurations there will be one control panel per two trains and the odd numbered train in a single control panel.
- B. The PLC Control Panel will include the necessary input/output plus 20% spare I/O. All I/O will be wired to field terminations and include surge arresting and isolation as required.
- C. The Instrumentation and Controls submittals will contain the following drawings:
  - Panel layout drawings and I/O layout per I/O card (per the ACTIFLO® Scope of Supply)
  - Panel power distribution drawing (internal to the panel only)
  - Loop wiring diagrams
    - These loops will detail the ACTIFLO® equipment and the necessary controls for the ACTIFLO® equipment.
    - Systems outside of the ACTIFLO® scope will only show terminal connections details to the ACTIFLO® Control Panel.
- D. The Instrumentation and Controls submittals will not have any of the following drawings:
  - P&ID's
  - One-line power diagrams
  - Installation details of the panels
- E. Unless specifically set forth in the ACTIFLO® Scope of Supply, this offer does not include:
  - Interconnecting wiring and/or conduit
  - UPS backup
  - VFDs

- Fiber optic cable
- Fiber optic cable termination
- Installation labor/supervision
- Motor control equipment
- Power distribution equipment
- Motor starters, contactors, reversing contactors
- Local control panels
- Sample pumps
- Junction boxes
- Samplers
- Instrument and other mounting stands
- Mounting hardware and supports for float switches
- Intrinsically safe relays & intrinsically safe relays panels
- Computer furniture
- Sun shields
- Primary flow measurement devices (such as parshall flumes)
- Instrument winterization
- Air conditioners or heaters
- Field mounted surge arrestors (power and signal)
- Instrument mounting hardware
- Piping, if needed, from the process to any remote mounted transmitters
- Local disconnects

## 2.16 PROCESS INSTRUMENTATION

### A. Turbidity/TSS Monitoring

1. The suspended solids and turbidity analyzer shall consist of a self-cleaning PVC or stainless steel immersion or insertion probe with 33' (10m) cable, microprocessor-controlled interface module and power supply. The connections between the turbidimeter and interface unit will include plug & play connections.
2. The analyzer shall measure turbidity or suspended solids or both dependent on the probe selected. The probe has a self-cleaning system preventing erroneous values and maintenance problems caused by gas bubbles and sludge particles, requiring almost no maintenance. Measurements are accurate, continuous, and completely independent of color.
3. The analyzer operates with a user-selected measurement range of 0.001 to 1000 NTU for turbidity, and 0.001 to 50.0 g/L for suspended solids. An operating temperature of 32 to 104 °F for the probe and -4 to 104 °F for the interface module. Response time is less than 1 second and is user-adjustable up to 5 minutes. The accuracy is less than 1% of reading or  $\pm 0.001$  NTU, whichever is greater for turbidity and less than 5% of reading for suspended solids.

Repeatability for turbidity is less than 1% of reading, and less than 3% for suspended solids reading.

4. The turbidimeter(s) shall be Hach Solitax or equal.

B. pH Monitoring

1. pH Sensor

- a. The pH or ORP sensor shall be of Differential Electrode Technique design using two measuring electrodes to compare the process value to a stable internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling-resistant characteristics.
- b. The sensor shall have a hex-shaped body to facilitate mounting, and shall be constructed of PEEK® material for exceptional chemical resistance and mechanical strength. This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together.
- c. The sensor shall have a:
  1. Convertible body style featuring 1-inch NPT threads on both ends to mount into a standard 1-inch pipe tee, into a Hach adapter pipe for union mounting with a standard 1-1/2 inch tee, or onto the end of a pipe for immersion into a vessel.
  2. Insertion body style featuring 1-inch NPT threads only on the cable end to mount into a Hach ball valve hardware assembly, enabling the sensor to be inserted into or retracted from the process without stopping the process flow.
  3. Sanitary body style featuring an integral 2-inch flange to mount into a Hach 2-inch sanitary tee. The sanitary body style sensor shall include a special cap and EDPM compound gasket for use with the Hach sanitary hardware.
- d. The built-in electronics of the sensor shall be completely encapsulated for protection from moisture and humidity.
- e. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 m (328 ft.) with standard cabling and up to 1000 m (3280 ft.) with a termination box.
- f. The sensor signal shall have an integral temperature sensor. The pH sensor shall automatically compensate measured values for changes in process temperature.
- g. The ORP sensor shall include a titanium ground electrode (standard) to eliminate ground loop currents in the measuring electrodes.
- h. The sensor shall have a measuring range for pH of 0.00 to 14.00.
- i. The sensor shall be Hach Company Model pHD sc.

2. pH Controller

- a. The pH or ORP sensor shall be of Differential Electrode Technique design using two measuring electrodes to compare the process value to a stable

internal reference standard buffer solution. The standard electrode shall have non-flowing and fouling-resistant characteristics.

- b. The sensor shall have a hex-shaped body to facilitate mounting, and shall be constructed of PEEK® material for exceptional chemical resistance and mechanical strength. This material shall enable the sensor to be installed in metal fittings without leakage usually caused by heating and cooling cycles when dissimilar materials are threaded together.
- c. The sensor shall be capable of the following installation styles:
  - 1. Convertible body style featuring 1-inch NPT threads on both ends to mount into a standard 1-inch pipe tee, into a Hach adapter pipe for union mounting with a standard 1-1/2 inch tee, or onto the end of a pipe for immersion into a vessel.
  - 2. Insertion body style featuring 1-inch NPT threads only on the cable end to mount into a Hach ball valve hardware assembly, enabling the sensor to be inserted into or retracted from the process without stopping the process flow.
- d. The built-in electronics of the sensor shall be completely encapsulated for protection from moisture and humidity.
- e. The sensor shall have a built-in preamplifier to enable the signal to be transmitted up to 100 m (328 ft.) with standard cabling and up to 1000 m (3280 ft.) with a termination box.
- f. The sensor signal shall have an integral temperature sensor. The pH sensor shall automatically compensate measured values for changes in process temperature.
- g. The sensor shall have a measuring range for pH of 0.00 to 14.00.
- h. The sensor shall be Hach Company Model pHD sc or pHD for pH or ORP measurement.

#### C. Flow Meter

- 1. The magnetic flowmeter shall be obstructionless and operate by means of pulsed DC coil excitation. The flow tube shall be constructed of 304 stainless steel, with a Hard Rubber liner, 316 stainless steel electrodes, and ANSI Class 150 steel flanges. The electromagnetic induction flowmeter shall generate a voltage linearly proportional to flow for full-scale velocity settings from two to 33 feet per second. Standard accuracy of the pulse output shall be +/- 0.2% of rate +/- 0.01% of full scale (33 ft/sec) for all meters. The meter body shall be available for temporary submersion to 30 feet of water for up to 48 hours where specified. The meter body shall include grounding and empty pipe electrodes of the same material as the measuring electrodes. Ground probes, rings, or straps will not be acceptable.
- 2. The meter shall incorporate a high impedance amplifier of 1012 ohms or greater, eliminating the effect of buildup on the electrodes. The meter shall utilize bipolar pulsed DC coil excitation with automatic coil-current fine tuning by the microcontroller to adjust the sensor current within a tolerance of ±100mA. The amplifier shall incorporate 3-stage signal processing to maintain system accuracy by the use of a 26 bit analog digital converter. The first stage will adjust the common-mode rejection ratio to filter out noise. The second stage will incorporate an INTEGRATED AUTOZERO function which compensates for any

external interference signals and eliminates zero drift. Manual zero adjustments shall not be required -- even at start-up. And in stage three the measuring signal will be amplified by an AUTOGAIN function, depending on the actual amplitude of the flow signal, to automatically increase the measurement resolution at various flow rates, providing a turndown of at least 1000:1. To further insure the specified accuracy, the electronics shall automatically perform an internal temperature drift compensation. Power consumption shall be no more than 15 VA, independent of meter size. Upon any power failure the unit will retain all setup parameters and accumulated measurements internally in non-volatile memory. All units will be protected against voltage spikes from the power source by utilizing internal transient protection.

3. The signal converter shall be either integrally mounted on the flow tube or remotely mounted up to 6500 feet from the flow tube. It shall be powered by 110V, 60 Hz power and provide both a 4 – 20 mA flow rate signal and a scaled 0 – 10 KHz pulse output for remote totalization.
4. The flowmeter shall have optical Touch Control programming which can be operated through the enclosure window, without opening the electrical enclosure. The flowmeter shall have a 4-line x 16 character backlit LCD display used for programming as well as for simultaneous display of flow rate and total flow in user-selectable engineering units, and readout of diagnostic error messages, selectable from 12 standard languages. The microprocessor shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected. The electronics shall include infinitely adjustable low flow cutoff.
5. Outputs shall be an isolated 4-20 mA DC into 700 ohms load, proportional to flow rate plus a scaled 24 VDC pulse or open collector frequency output operating at frequencies up to 10 kHz an adjustable pulse width (0.05 to 2 sec). The analog output shall have an adjustable response time from 0.05 to 100 seconds. A digital filter will be integral for compatibility with the process fluid. The transmitter housing shall be powder coated cast aluminum of NEMA 4X rating. Both auxiliary (open collector) and current inputs. Aux input supply voltage from 3 to 30 VDC resistance of 5K ohms and configurable for re-setting totalizer(s), measured-value suppression, error message reset, and start/pause batching. Active or passive current input (4-20mA @ resistance less than or equal to 150 ohms). The magnetic flowmeter shall provide 2 programmable relay outputs, for diagnostic error output, MAX/MIN flow rate set points, dual ranging, empty pipe detection, flow direction or for batching.
6. The meter body shall be available in flanged or wafer styles, or with custom connectors (NPT fittings, Tri Clamps, hose fittings, or butt-weld connectors) as specified in the data sheets. Liner and electrodes shall be chosen to be compatible with the process fluid. All fluids require a minimum conductivity of 5mS/cm.
7. The standard meter will be FM approved non-incendive Class I, Div. 2 Groups A-D, with units available that have FM Class I, Div. 1 approval.

8. The magnetic flowmeters shall be of the Endress+Hauser Promag 400W Series or user approved equal.

D. Pressure Transmitter

1. For use in measuring the discharge pressure of the Sand recirculation pump. The transmitter shall convert the sensed pressure to an analog 4 to 20 mA electrical signal that will interface with the PLC.
2. The pressure transmitter shall measure pressure in the range of 1.5 ~ 60 PSI.
3. The pressure transmitter shall have a ceramic flush mounted diaphragm.
4. The pressure transmitter will have 0.5" process connection. The process connection shall be threaded ANSI MNPT 316L. The sensor seal shall be FKM Viton. The pressure transmitter connection shall not require a manifold or additional seal.
5. The pressure transmitter shall be capable of measuring process conditions of -40°F to 257° and capable of operating in an ambient temperature of -40°F to 185°F. The unit shall be able to handle a max overpressure of 900PSI.
6. Supply voltage shall be 11.5 to 45 VDC for non-hazardous areas and 11.5 to 30VDC for hazardous areas. The unit shall be loop powered.
7. The pressure transmitter shall be available with 4-20mA output or 4-20mA with superposed HART protocol. The type of output shall be selected at the time of product configuration based on field requirements.
8. Local display shall be plug-in liquid crystal display (LCD). The display will indicate corresponding pressure with a 4-digit display and bar graph. The display can be rotated in 90° increments.
9. Operating elements will be located under the local display that allow calibrating of lower range value (zero), upper range value (span) and dip switch for dampening on/off.
10. The pressure transmitter housing shall be die cast aluminum with powder protective coating. The transmitter will be equipped with a ½" NPT connection for electrical wiring.
11. The pressure transmitter shall be Endress & Hauser Cerabar M PMC71.

## 2.17 POLYMER PROCESSING SYSTEM

### A. Dry Preparation System

1. The module shall be sized for usage of up to 1 pound per hour at a 0.3 percent solution, aged for at least 1 hour.
2. The automatic polymer preparation/dilution system shall be an integrated equipment package capable of automatically preparing a homogenous polymer solution. The system shall be an automatically controlled, sequentially batching unit consisting of a high shear, first stage wetting system, a mix tank with a low shear mixer, and an aging tank. The system shall continuously supply the resulting polymer solution to one or more devices designed to automatically meter, dilute and feed stock polymer solution to point of use.
3. The Polymer Preparation System shall have the capability to automatically prepare dry polymers. The entire system shall be an integrated package pre-piped, pre-wired, skid mounted system to the most practical extent for shipping. This configuration shall provide for a complete polymer preparation system occupying the smallest possible space.
4. The system storage hopper should have a minimum capacity of 2 cu. ft. and will be constructed of 304 SS or carbon steel. The storage hopper shall include a low level switch for monitoring polymer supply levels. Low level conditions will include a visual alarm in the control panel.
5. The dry feeder will include either a dissimilar speed, double concentric auger metering mechanism to condition the material to a consistent bulk density and fill the auger from a full 360 degrees, or an integral flexible hopper to prevent powder bridging. The screw feeder will be constructed of 316 SS. The feeder will include a 304 SS discharge spout and should include provisions for preventing moisture contact with the dry powder. The feeder shall be driven by a totally enclosed variable speed motor, with the motor controller mounted inside the panel. The feeder shall be controlled by an adjustable timer accessed through the touchscreen display
6. The wetting system shall incorporate a mixing action with sufficient means for ensuring complete wetting of each polymer particle. No restrictive orifices should be utilized and the wetting system should incorporate a containment reservoir to prevent spillage in the event of an overflow condition. In the event of a containment reservoir overflow, the system shall signal an alarm and immediately shutdown. Wetting system shall include a clear synthetic cover to allow for visual inspection. All surfaces that come into contact with the wetted polymer shall be constructed of 304 SS. Means for transporting the wetted polymer to the mixing tank should be attached directly to the outlet of the wetting chamber. Means for preventing backflow of polymer solution should also be incorporated.
7. The system to include dedicated mixing and aging tanks. Mixing and aging tanks to be constructed of 304 SS. Mixing tanks to be located above aging tank to reduce floor space and arrangement must include means for accessing tank internals. Tanks accessories to include mixing tank transfer valve, level transmitters, and drain valves. Aging tank shall include an outlet valve and labyrinth baffles to promote a plug flow pattern within the tank to optimize polymer detention. Open-top tanks will not be acceptable. The mixing tank shall have a minimum



capacity of 25 gallons, and the aging tank shall have a minimum capacity of 50 gallons to provide at least 1 hour aging time when feeding 0.3 percent solution at the maximum dry polymer usage

8. The mixing tank will be provided with a mechanical mixer suited with hydro-foil type impeller capable of operation at varying tank levels. Impeller and shaft to be constructed with 304 or 316 Stainless steel. Shaft to be coupled with integral gear reducer.
9. The water supply line shall be sweated copper and shall include pressure reducing valve, pressure switch with high and low contacts, solenoid valve, pressure gauge and visual flow meter. Water supply shall be 20 gpm filtered water at 25 psig.
10. Package system to include pre-mounted and pre-wired NEMA 4X control panel including Allen-Bradley PLC with Ethernet and 10" color touchscreen operator interface. Control Panel shall automatically operate the entire preparation system and components thereof. The panel shall also include a main disconnect and an emergency stop push-button. PLC program shall include interlocks to prevent feeding of dry polymer unless water is being supplied to the wetting chamber and all motors are operational. Interlocks shall trigger a visual alarm. Should the system experience a loss of power, the PLC shall remember where in the sequence of operation the polymer preparation system was interrupted and continue from that point when power is restored and system restarted. Control panel shall include motor starters and necessary wiring to respective motors to the greatest extent possible. System power requirements shall be 460 volt, 60 Hertz, 3 phase. Transformers, if required, shall be provided to step voltage down from 480 volts to 115 volts.
11. The color touchscreen operator interface shall provide the following capabilities at a minimum:
  - "Process" screen, showing on/open status of all components during system operation.
  - Continuous level displays for both the mixing and aging tanks.
  - Resettable batch counter.
  - Alarm acknowledge and reset buttons.
  - Password protection.
  - "Alarm" screen showing all possible alarms, noting which alarms are currently present.
  - Alarm 'history' screen.
  - "Timers" screen, allowing the operator to set feeder, mixer, and emulsion pump timers, in addition to various system delay timers.
  - "Switches" screen, including H/O/A switches for all major components.
  - Local/Remote capability.
  - "Levels" screen, allowing the operator to set mixing and aging tank control and alarm levels.
12. System to be manufactured by VWS , Acrison, or equivalent as supplied by Kruger.

## 2.19 POLYMER METERING PUMPS

### GENERAL

- A. Acceptable Manufacturers

The dilute polymer feed skid system described in this section shall contain progressing cavity pumps as manufactured by Moyno or Seepex Pumps. For another manufacturer to be determined acceptable for providing progressing cavity pumps on this project, it must supply references of five separate, substantially similar installations with contact names and phone numbers. Referenced installations must be for the same chemicals required in this specification and have been in satisfactory operation for a minimum of 2 years.

- B. The dilute polymer feed skid shall be self-contained and designed to feed required concentrations of polymer. Each polymer feed skid shall include (2) single stage progressing cavity pumps. The progressing cavity pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller to be provided by the skid or pump manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.

C. Dual Pump Chemical Metering Skid:

1. The polymer feed skid shall be constructed of heavy duty corrosion resistant material with adequate supports for all equipment and piping. Forklift truck cut outs to be provided. Each progressing cavity pump shall be mounted onto an individual baseplate as a pump unit. Each pump unit shall contain a single stage progressing cavity pump with independently mounted gear reducer and NEMA motor. Each pump unit shall be shimmed, aligned, and built independently of the structural skid.
2. Polymer feed pump system piping shall include: one (1) Y-Strainer in the suction header piping in duty/standby configuration with one (1) common calibration column, one (1) high pressure cut off switch per pump, one (1) pressure gauge per pump, two (2) check valves, one (1) dilution water line, all required piping, valves, supports, and flushing ports. All piping shall include isolation valves and unions for all serviceable components. Pump skid dilution water line shall contain one (1) check valve, one (1) solenoid valve, one (1) throttle valve, one (1) rotameter, one (1) pressure gauge, two (2) ball valves, one (1) static mixer with diluted polymer discharge connection mounted on the vertical back panel.
3. All piping shall be schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.

D. Chemical Metering Pump:

1. Pump Type: Positive displacement progressing cavity pump. Pump shall be capable of handling high viscosity polymer.

2. Provide manual speed adjustment, 0-100%, in 1% increments.
  - a. Provide ability to adjust speed while pump is operating.
3. Drive:
  - a. Variable Speed Motor with Controller
  - b. TEFC/TENV Enclosure
4. Materials
  - a. Housing: Cast Iron or 316 Stainless Steel
  - b. Bearings: Grease Lubricated Roller Type
  - c. PTFE Packing or Mechanical Seal
  - d. Rotor and Drive Train: Chrome Plated hardened Alloy or 316 Stainless Steel
  - e. Stator: 70 dM Nitrile or Viton
5. The pumps shall have the following Remote Control Outputs (To Kruger PLC):
  - a. Dry contact for Auto Status
  - b. Dry contact for Run Status
  - c. Dry contact Fail Status
6. The pumps shall have the following Remote Control Inputs (From Kruger PLC):
  - a. Dry contact for Start/Stop Command
  - b. Dry contact for Speed Comma

#### ACCESSORIES

##### A. Calibration Cylinders:

1. Calibration cylinders shall be provided and installed in the chemical supply piping. The cylinder shall be vented back to the chemical supply. The calibration cylinder shall be sized for a **30 second draw down** at maximum pumping rate.
2. Materials
  - a. Cylinder Body: Clear PVC
  - b. End Caps: PVC

##### B. Pressure Switches:

1. Provide an in-line adjustable Pressure Switch on the discharge side of each pump. The switch shall be wired to the local control panel and stop pump and dilution water on increasing pressure threshold.

2. Materials:
  - a. Body: Brass
  - b. Diaphragm: Buna
  - c. Sized to match line size

C. Check Valves:

1. Provide in-line vertically mounted check valve on discharge side of each pump and dilution water line.
2. Materials:
  - a. Body: PVC
  - b. Seals: FPM or Viton or EPDM
  - c. Sized to match line size

D. Controls:

1. Each skid shall be provided with a single wall or skid mounted control panel for both pumps or shall be provided with a skid-mounted termination box and controller unit.
2. Provide main disconnect mounted in local control panel or as integral part of controller unit.
3. Utilize common terminal strip for electrical connections.
  - a. Provide terminals for single 120V 1 phase input or 460V 3 phase input.
4. All internal skid wiring to be terminated in NEMA 4X control panel or NEMA 4X terminal box located on skid prior to shipment. Required external power sources and control connections to be provided by installing contractor.
5. Provide a hand/off/auto selector switch mounted on the control panel or terminal box.
  - a. Provide auxiliary contact for remote indication of hand/off/auto selection
6. Provide Running, Fail, and High Pressure Alarm indicating lights for each pump.
7. In Hand, motor speed adjustments shall take place via panel-mounted speed adjustment knob or controller unit keypad.
8. In Auto, the pump shall be frequency adjusted by 4-20 mA flow signal through a controller provided by the skid or pump manufacturer.
9. All required skid functionality should take place via local control panel or controller unit and junction box. This includes, but is not limited to, pump protection instrumentation and dilution water control while pump is in both automatic and hand operation.
10. All enclosures shall be rated NEMA 4X with all switches, indicator lights, and knobs mounted on the termination box or local panel door.

E. Pump Design Criteria

Type of application	Drinking Water
No. Pumps Required	1 Duty, 1 Standby
Pump Capacity Range (gph)	2.5-50
Pump Discharge Pressure @ Capacity (psi)	TBD
Polymer Dosage Range (mg/L)	0.3-1.0
Prepared Polymer Concentration (%)	0.3
Secondary Dilution Water Capacity (gph)	12.5-500

## 2.20 COAGULANT/FILTER AID METERING PUMPS

### GENERAL

#### A. Acceptable Manufacturers

The chemical metering pump skid systems of this section shall be manufactured by ProMinent Fluid Controls or Grundfos Group. For another manufacturer to be determined acceptable for providing diaphragm chemical metering skids on this project, it must supply references of five separate, substantially similar installations with contact names and phone numbers. Referenced installations must be for the same chemicals required in this specification and have been in satisfactory operation for a minimum of 2 years.

- B. The chemical metering skid shall be self-contained and designed to feed required amounts of Coagulant. Each chemical metering skid shall include (2) simplex head chemical metering pumps. The metering pumps shall be capable of both manual and automatic control. Automatic control shall be accomplished by following a 4-20 mA control signal through a controller provided by the skid or pump manufacturer. The metering pump skid will be completely assembled, wired, and pre-tested prior to delivery to the job site.

#### C. Dual Pump Chemical Metering Skid:

1. The chemical metering skid shall be constructed of fusion welded, black uv-protected polypropylene sheets with adequate supports for all equipment and piping. Forklift truck cut outs to be provided. The base will have a metal mounting plate and a polypropylene top plate.
2. Chemical metering pump system piping shall include: one (1) Y-Strainer for coagulant feed located in the suction header piping, (1) pressure relief valve per pump, one (1) pulsation dampener per pump, one (1) pressure gauge with diaphragm seal per pump, one (1) check valve per pump, one (1) back pressure valve per pump, one (1) calibration cylinder per pump and all required piping, valves, supports, and flushing ports. All piping shall include isolation valves and unions for all serviceable components.

3. All piping shall be schedule 80 PVC and assembled by the skid manufacturer. All piping shall be socket-welded using standard procedures. Where threaded connections need to be made the manufacturer will utilize Teflon tape and a suitable thread sealant.

D. Chemical Metering Pump:

1. Pump Type: Positive displacement solenoid/mechanically/hydraulically actuated simplex head diaphragm pump. Suction and discharge strokes shall be controlled by single ball check valves. Check valves must be interchangeable.
2. Provide manual stroke length adjustment, 0-100%, in 1% increments.
  - a. Provide ability to adjust stroke while pump is operating.
  - b. For microprocessor driven pumps, stroke length may be adjusted automatically by the microprocessor.
3. Drive:
  - a. Variable Speed Motor with Controller
  - b. TEFC/TENV Enclosure
4. Materials
  - a. Diaphragm: Steel Core, Nylon Reinforced Teflon Faced EPDM
  - b. Valve Ball: Aluminum Oxide Ceramic
  - c. Valve Body: PVDF (Kynar)/PVC
    - a. Check Valve Seal: PTFE/PVC
    - b. Other Wetted Parts: PVDF/PVC
    - c. Reciprocating Shaft: Steel
    - d. Housing: Cast Aluminum inner housing with either Glass-filled Luranyl or Acrylic Resin coated outer housing.
6. The pumps shall have the following Remote Control Outputs (To Kruger PLC):
  - a. Dry contact for Run Status
  - b. Dry contact for Fail Status
7. The pumps shall have the following Remote Control Inputs (From Kruger PLC):
  - a. Dry contact for Start/Stop Command
  - b. Dry contact for Speed Command

ACCESSORIES

A. Calibration Cylinders:

1. Calibration cylinders shall be provided and installed in the chemical supply piping. The cylinder shall be vented back to the chemical supply. The calibration cylinder shall be sized for a 1-minute draw down at maximum pumping rate.

2. Materials

- a. Cylinder Body: Clear PVC
- b. End Caps: PVC

B. Check Valves:

1. Provide in-line vertically mounted check valve on discharge side of each pump

2. Materials:

- a. Body: PVC
- b. Seals: FPM or Viton or EPDM
- c. Sized to match line size

C. Pulsation Dampener:

1. Type: Bladder/bellows type dampener with dry side precharged with air. Pressure gauge on dry side of bladder/bellows provides indication of precharge pressure. Unit can be disassembled for removal and replacement of bladder/bellows. Valve on dry side allows for air recharge after servicing. The pulsation dampener shall be sized per the manufacturer's recommendations.

2. Materials

- a. Body: PVC
- b. Bladder: Viton

C. Pressure Relief Valve:

1. Provide in-line pressure relief valve on the discharge side of each pump head. The relief side of the valve shall be plumbed to the supply side of each metering pump.

2. Materials:

- a. Body: PVC
- b. Diaphragm: Teflon-faced EPDM
- c. Sized to match line size
- d. Relief Pressure: 0 to 150 PSI adjustable, factory set at 70 PSI

D. Backpressure Valves:

1. Provide in-line backpressure valve on discharge pipe side of each pump.
2. Materials:
  - a. Body: PVC
  - b. Diaphragm: Teflon faced EPDM
  - c. Sized to match line size
  - d. Backpressure Provided: 0 to 150 PSI adjustable, factory set at 60 PSI

E. Controls:

1. Based on pump selection, if required, each skid shall be provided with a skid mounted control panel for both pumps, or shall be provided with a skid-mounted termination box with number of power receptacles matching number of pumps.
2. Provide main disconnect mounted in control panel (not applicable for skids with terminal box designs or where controls are integral to the pump housing)
3. Utilize common terminal strip for electrical connections.
  - a. Provide terminals for single 120V 1 phase input.
4. All internal skid wiring to be terminated in NEMA 4X control panel or NEMA 4X terminal box prior to shipment. Required external power sources and control connections to be provided by installing contractor.
5. Provide a hand/off/auto selector switch mounted on the control panel. For microprocessor driven pumps, hand/off/auto selection is via pump keypad.
6. Provide Running and Fail indicating lights for each pump.
7. In Hand, the pump stroke frequency shall be manually adjusted with a manual stroke adjustment potentiometer. For microprocessor driven pumps, stroke adjustment may take place via pump keypad, or may be adjusted automatically by the microprocessor.
8. In Auto, the pump shall be frequency adjusted by 4-20 mA signal through a controller provided by the skid or pump manufacturer.
9. In hand, motor speed adjustments shall take place via the local panel or motor controller keypad or pump keypad for microprocessor driven pumps.
10. All enclosures shall be rated NEMA 4X fiberglass. When applicable all switches shall be mounted on enclosure door.

G. Pump Design Criteria

Type of application	Drinking	Water
Coagulant		
No. Pumps Required	1 duty + 1standby per	
train		
Pump Capacity Range (gph)	0 – 8	
Pump Discharge Pressure @ Capacity (psi)	30	



Coagulant Dosage Range (mg/L)	0 – 75
Coagulant Type	Ferric
Coagulant Specific Gravity	1.43
Coagulant Percent Active (%)	40
Type of application Aid	Drinking Water Filter
No. Pumps Required	1 Duty + 1 Standby
Pump Capacity Range (gph)	0.1-1.0
Pump Discharge Pressure @ Capacity (psi)	TBD
Coagulant Dosage Range (mg/L)	1-5
Coagulant Type	Ferric
Coagulant Specific Gravity	1.43
Coagulant Percent Active (%)	40

## 2.22 MICROSAND

### A. General

Microsand for the ACTIFLO® system shall be supplied by Kruger. The microsand should have an effective size of 80-134 microns depending on the application, uniformity coefficient of < 1.7 and shall contain 90 to 99% pure silica sand.

The ACTIFLO® Supplier will provide appropriate type and quantity of microsand for system start-up.

## 2.23 MICROSAND RECIRCULATION PIPING (Not Supplied by Krüger)

### A. General

Microsand recirculation piping shall be constructed of 304/316 stainless steel, HDPE, lined ductile iron, or painted carbon steel. Steel pipe must include a minimum Schedule 40 wall thickness.

HDPE must be certified to conform to NSF-61 standards and meet the requirements of ASTM PE4710 and ASTM F714. Welding shall be performed in accordance with written procedures consistent with the requirements of Plastic Pipe Institute TR-41 Generic Saddle Fusion Joining Procedure and Plastic Pipe Institute TR-33 Generic Butt Fusion Joining Procedure. Butt Fusion joints are to be used when possible and all fabricated fitting pressure ratings shall be a minimum of 100 psi.

All microsand recirculation piping shall be provided and installed by the Contractor.

## 2.24 Chemical Feed Dosing Locations (Not designed or Supplied by Kruger)

### A. General

The following chemical dosing locations shall be provided:

#### 1. pH adjustment

The following dosing locations for pH adjustment feed points should be provided. Proper dispersion of any needed pH adjustment to ensure proper coagulation and flocculation, is required upstream of the ACTIFLO® unit. All feed piping shall be designed by others and provided and installed by the Contractor.

##### a. Upstream of ACTIFLO – pH adjustment

#### 2. Primary Coagulant

The following dosing locations for Primary Coagulant feed points within the ACTIFLO system should be provided. Dosing locations should be provided for each train. Please reference the additional details in the ACTIFLO suppliers IO&M manuals. All coagulant feed piping shall be designed by others and provided and installed by the Contractor.

##### a. PAC / Coagulation Tank Weir wall

#### 3. Post Coagulant

Proper dispersion of post coagulant shall be provided downstream of ACTIFLO and prior to filtration. Dosing location shall be in a well-mixed location (i.e., Effluent troughs of ACTIFLO) and be designed to provide a consistent output. Due to small flow rates, this may require reducing lines sizes at injection point to ensure proper line velocities are achieved to aid in a consistent output.

#### 4. Polymer

The following dosing locations for polymer feed points within the ACTIFLO system should be provided. Dosing locations should be provided for each train and include isolation valves for directing polymer to either location. Please reference the additional details in the ACTIFLO suppliers IO&M manuals. All polymer feed piping shall be designed by others and provided and installed by the Contractor.

- b. Coagulation / Maturation Tank Weir wall
- c. Draft Tube

## 2.25 POLYMER

### A. General

Polymer for the ACTIFLO® system shall be Hydrex brand, as supplied by Kruger Inc. Based on the application, the ACTIFLO® supplier shall determine the polymer type, as it relates to charge, charge density, and molecular weight.

For 24/7 operation applications the ACTIFLO® Supplier will provide a one-month supply of the appropriate polymer for system start-up.

## PART 3 – EXECUTION

### 3.01 INSTALLATION

- A. Installation shall be in strict accordance with the Supplier's instruction and recommendations in the locations shown on the Drawings. Installation shall include furnishing the required oil and grease for initial operation. The grades of oil and grease shall be in accordance with the Supplier's recommendations.
- B. All equipment, components, piping and appurtenances shall be installed true to alignment rigidly supported. Any damage caused by the negligence of the Contractor to the above items shall be repaired or replaced by the Contractor to its original condition.
- C. The equipment and accessories shall be installed in accordance with the supplier's instruction and located as shown on the Drawings to form a complete workable system.
- D. Interconnecting piping supplied by the Contractor shall be hydrostatically tested by the Contractor.

### 3.02 Contractor Scope of work

**The following is a non-inclusive list of material that shall be furnished by the Contractor:**

1. Obtain necessary construction permits and licenses, construction drawings (including interconnecting piping drawings), field office space, telephone service, and temporary electrical service.
2. Video recording of any training activities.
3. All site preparation, grading, locating foundation placement, excavation for foundation, underground piping, conduits and drains.
4. Demolition and/or removal of any existing structures, equipment or facilities required for construction, and installation of the ACTIFLO® system.
5. Supply and install all bulk storage tanks, pads, and supports including the concrete basins required for the ACTIFLO® system
6. Install and provide grout for the bottom of the settling tank sloped floor. Installation should be per installation instructions as defined in the Equipment Section of the IO&M, at which the Scraper arms should be used to screed the grout.
7. Provide all concrete work for the ACTIFLO® tankage, including all corner fillets.
8. Provide and installation of all foundations, supply and installation of all embedded or underground piping, conduits and drains.
9. All backfill, compaction, finish grading, earthwork and final paving
10. Receiving (preparation of receiving reports), unloading, storage, maintenance preservation and protection of all equipment, and materials provided by Kruger.
11. Installation of all equipment and materials provided by Kruger.
12. Supply, fabrication, installation, cleaning, pickling, and/or passivation of all stainless steel piping components.
13. Provide all imbedded pipe sections and valves for tank drains.
14. All cutting, welding, fitting, and finishing for all field fabricated piping.
15. Supply and installation of all flange gaskets and bolts for all piping components.
16. Supply and installation of all pipe supports.
17. Install and terminate all motor control centers, motor starters, panels, transformers, instrumentation, and VFD's.
18. Provisions for pH/Alkalinity adjustment and any chemical feed systems not provided by Kruger.
19. Reliable and accurate flow signal for each ACTIFLO System Train for chem feed pacing.
20. Pre-screening (if not provided by Kruger) equipment (3 mm) prior to ACTIFLO System

21. Dispersion Mixing Device (if not provided by Kruger), for properly dispersing Coagulant upstream of the ACTIFLO system
22. Install and terminate all motor control centers, motor starters, panels, transformers, instrumentation, and VFD's.
23. Provide all panels not supplied by Kruger.
24. Provide, install and terminate all variable frequency drive units as required by Kruger for each maturation tank mixer and each settling tank scraper.
25. Instrumentation: Supply and install all sample pumps and sample lines required for any instrumentation provided by Kruger.
26. Instrumentation: Installation and mounting of all Kruger provided process instrumentation per manufactures recommendations to include any pipe penetrations, welding and/or field fabricated items needed. If applicable, this includes but is not limited to inline sensors such as turbidimeter sensors which require angled tap/weld to influent piping. If the Influent Turbidimeter is to be installed in Ductile Iron Pipe, a Stainless Steel spool piece with flanged ends will be required, and the Turbidimeter flanged adapter will require welding to the spool piece. The supply, installation and welding of the described spool piece is by others.
27. Labor and material for winterizing the ACTIFLO® System; insulating/heat tracing any tanks, piping, or tubing subjected to freezing temperatures, and water heaters when polymer solution make-up water is expected to fall below 55 °F. Polymer solution make-up water should be potable.
28. Supply and install all electrical power and control wiring and conduit to the equipment served plus interconnection between the ACTIFLO® Supplier's furnished equipment as required, including wire, cable, junction boxes, fittings, conduit, etc.
29. Supply and install all insulation, supports, drains, hold down clamps, manhole covers, condensate drain systems, wastewater valves, flanges, flex pipe joints, expansion joints, boots, gaskets, adhesives, fasteners, safety signs, and all specialty items such as strainers and traps.
30. Provide all labor, materials, supplies and utilities as required for start-up, performance testing including laboratory facilities, analytical work.
31. Provide all chemicals (not provided by Kruger), lubricants, glycol, oils, or grease and other supplies required for equipment start-up or plant operation.
32. Provide all anchor bolts and mounting hardware.
33. Provide and install all piping required to interconnect to the ACTIFLO® Supplier's equipment including all microsand recirculation piping.
34. Provide all nameplates, safety signs and labels.
35. Provide, and install all support beams and/or slabs for scrapers, mixers, and/or chemical feed systems.
36. Provide all gratings, handrails, access hatches, ladders, and access platforms.
37. The Contractor shall coordinate the installation and timing of interface points such as piping and electrical with the ACTIFLO® Supplier.

- 38. Supply and install all sunshields and/or additional enclosures as needed when installing ACTIFLO® equipment and instrumentation outdoors.
- 39. All other necessary equipment, materials and services not otherwise listed as specifically supplied by Kruger.

### 3.03 PROTECTIVE COATINGS

- A. All fabricated steel parts, excluding stainless steel, shall be factory finish painted in accordance with the Equipment Manufacturer's standard painting specifications

### 3.04 SUPPLIER'S SERVICES

- A. Preliminary field testing, inspection, and checkout of the entire ACTIFLO® system, following installation, shall be performed by a qualified representative of both the Supplier and Contractor. Tests shall be conducted to demonstrate to the Engineer that all system components furnished by the ACTIFLO® Supplier are fully operational, that all connecting piping is leakproof and properly anchored, and that the entire system furnished by the ACTIFLO® supplier is ready for continuous safe operation. The purpose of the checkout shall be to ensure that each individual system component has been correctly installed, shall operate fully in the manner intended, and is ready to perform its function as part of an integrated system when placed in continuous operation.
- B. When all preceding equipment tests have been satisfactorily performed and when water is available and can be suitably handled through the ACTIFLO® system, the ACTIFLO® system shall be started. The Supplier's representative shall supervise the Owner's operating personnel during the start-up period. Start-up operations shall be continued until it is satisfactorily demonstrated that the equipment is suitable for continuous on-line service.
- C. During the start-up period the process performance shall be evaluated for a minimum period of 2 eight-hour days. The owner shall provide for any necessary sampling and analysis during the testing period. Should the system meet satisfactory process performance requirements (or as required by the contract documents), the performance of the system shall be deemed successful and the ACTIFLO® system supplier shall be relieved of any further process performance obligations. In the event that the system does not meet satisfactory process performance requirements (or required by the contract documents), the 2-day test period shall be repeated.

- END OF SECTION -

END OF SECTION

The filter control system shall be the FilterWorx™ Automatic Control System or an Engineer approved equal, and shall include the following equipment and instrumentation.

1. Filter Control Console

A Filter Control Console shall be provided for controlling and monitoring the operation of all four filters.

The console shall be a PLC-based system and shall be provided complete with the necessary control devices, equipment, and functional programming to perform the control and monitoring functions specified.

The Filter Control Console shall be an AFC® 5000 as manufactured by Xylem Water Solutions USA, INC (LEOPOLD) or an Engineer approved equal.

a. Functional Description

The console shall have the capability of controlling the filtration and backwash sequence for four filters. It shall have the capability for semi-automatic, automatic, and manual control.

In the automatic mode, the backwash sequence shall be initiated by high turbidity, high loss-of-head, or exhausted filter runtime. The PLC shall perform the backwash sequence without operator intervention.

In the semi-automatic mode, the backwash sequence shall be manually initiated by the operator following a system alert based on the above-mentioned conditions. Occurrence of any of these conditions shall illuminate the BACKWASH REQUIRED pilot light. The operator shall initiate the backwash sequence by pressing the START BACKWASH pushbutton. The PLC shall then perform the backwash sequence without further operator intervention. An ABORT BACKWASH pushbutton shall be provided to end the backwash sequence before its completion. The console shall include an EXTEND HIGH BACKWASH pushbutton that will extend the high rate backwash for an adjustable amount of time.

In the manual mode, the backwash sequence shall be completely manual in operation, using the selector switches and indicators on the console. Manual operation shall be independent of the PLC.

An electronic valve positioner/controller shall be provided for the effluent and backwash control valves. The valve positioner/controller shall include AUTO/MANUAL and an INCREASE/DECREASE buttons. In AUTO mode, the unit shall accept a remote set point signal and position the flow control valve to maintain the flow set point. The remote effluent flow set point to each filter shall be generated by a common influent channel level transmitter. The remote backwash flow set point shall be generated from an output signal from the filter PLC based on the current backwash step. In MANUAL mode, the flow will be adjusted manually by pressing the appropriate INCREASE/DECREASE button. The unit shall have a dual LED display for indicating the flow set point and the actual flow in GPM.

The console shall have OPEN/HOLD/CLOSE selector switches for manual control of the effluent, backwash control and air scour vent valves. The console shall have OPEN/CLOSE selector switches for manual control of the influent, drain, backwash inlet, air scour inlet, and filter-to-waste valves. It shall also have START/STOP selector switches for the air scour blower(s) and backwash pump(s).

The console shall include an operator interface touchpad to monitor the operation of the PLC and adjust the system set points.

The console shall provide dry-contact open and dry-contact close outputs for each valve controlled from the console. It shall accept dry-contact limit switch inputs from each valve and shall have pilot lights for indication of fully opened and fully closed position. Motors shall be controlled via a single maintained dry-contact that shall close when the motor is to run. The console shall accept a dry-contact running signal for proof that the motor is running.

Digital indicators shall be provided for loss of head and turbidity.

NOTE: The contractor shall be responsible for ensuring that equipment supplied by others includes the necessary and proper signal interface.



b. Components

The enclosure shall be a totally enclosed, sloped top console, 96" in width. It shall be manufactured of fiberglass-reinforced plastic (FRP) having a minimum wall thickness of 1/8 inch (3.2 mm). The console enclosure shall be a model FCP as manufactured by Xylem Water Solutions USA, INC (LEOPOLD) or equal.

The electronic valve positioner/controllers shall be Leopold model Valve PAC® series II or equal.

The operator interface touchpad shall be Magelis model XBTR410 or equal.

Selector switches, pushbuttons, and pilot lights shall be Square D, Type ZB4, or equal. Pilot lights and illuminated pushbuttons shall be LED type.

Digital indicators shall be Red Lion "IMP" series, Precision Digital Trident series, or equal.

Control relays shall be general purpose, j plug-in type with LED pilot indicator, Square D, Class 8501, Type K or Type R, or equal.

Terminal blocks shall be Phoenix, or equal.

Circuit breakers shall be Square D, Class 9080, Type GCB, or equal.

The PLC system shall be a modular type and shall be designed to have 10% active spare input/output terminations. Spare I/O shall be wired to terminal blocks. The PLC shall have an Ethernet port for communications] The PLC system hardware shall be Modicon M340 or Allen-Bradley Compactlogix series. Final PLC selection shall be coordinated with plant-wide system integrator.

c. Wiring

The console shall be completely pre-wired except for wires to external devices, which shall be brought to lugless tubular screw with pressure plate terminal blocks. All wiring shall be in compliance with the National Electric Code (NEC).

Minimum wire size for 120 VAC power wiring shall be #16AWG stranded copper conductor, 600V, 90 degrees C with thermoplastic insulation. Minimum wire size for 24 VDC power wiring shall be #18 AWG stranded copper conductor, with thermoplastic insulation. Minimum wire size for DC signal wiring shall be #18 AWG twisted, shielded pair with drain wire (Belden 8760 or equal), grounded in accordance with ISA Recommended Practice for signal wiring. Wires shall be color coded as follows:

120 VAC, 2 wire, single phase:

Phase - L1, Black

Neutral-L2, White

Externally powered circuit - Yellow

120 VAC control - Red

24 VDC Control - Blue

Ground - Green, or green with yellow stripes.

## 2. Venturi Flow Meters

Each flow meter shall consist of a venturi type differential producing flow element and a differential pressure flow transmitter. Sizes and locations shall be as shown on the plans.

### a. Flow Elements

Primary flow elements shall be venturi type and shall— produce a differential pressure sensed at the inlet and at the throat.

The body shall be cast iron ASTM A126, Grade B. The throat bushing material shall be 304 SS. End connections shall be 125 ANSI flanges. Each tube shall be hydrostatically tested at 150 psi (1,034 kpa).

Two diametrically opposed main taps and two diametrically opposed throat taps shall be provided for differential pressure measurement connections. Centerline of the main taps and throat taps shall be in a horizontal plane. Holes shall be drilled at right angles to the axis and be burr free. Corner taps are not acceptable. A drain and a vent connection shall be provided at right angles to the main pressure taps when the tube is installed for steam or gas service.

All surfaces, except the throat and the flange faces, shall be coated with United States Environmental Protection Agency approved Series 20 Pota-Pox Epoxy-Polyamide Potable System or other coating approved by the USEPA for potable water applications.

The discharge coefficient shall not be less than 0.965 with uncalibrated accuracy of  $\pm 0.5\%$  over a range of 10:1 with a minimum Reynolds number which varies with tube size.

The venturi flow element shall be a Primary flow Signal HVT- CI model, or approved equal.

b. Flow Transmitters

Rate of flow transmitters shall be 2-wire type and shall generate a standard 4-20 mADC output signal. Each transmitter shall be supplied complete; with three-valve manifold.

The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be  $\pm 0.25\%$  of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).

The rate of flow transmitter shall be a Rosemount 3051 Smart DP, or approved equal.

3. Field Instrumentation

a. Filter Loss of Head Transmitters

A loss of head transmitter, complete with three-valve manifold, mudleg and strainer, shall be supplied to monitor the loss of head through each filter.

The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be  $\pm 0.25\%$  of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).

The loss of head transmitter shall be the Rosemount 3051 Smart DP, or approved equal.

b. Continuous Level Transmitters

A level transmitter shall be provided for each filter and the common influent channel.

The level sensing system shall consist of an ultrasonic-type, electronic continuous level transmitters, complete with sensing element and integral electronics. The sensors shall be powered by a nominal 24 VDC loop power supply and shall generate a standard 4-20 mADC output signal.

Mounting brackets to be provided by installation contractor based on site-specific requirements.

The level sensors shall be a Siemens SITRANS Probe LU Ultrasonic Level Transmitter, or approved equal.

c. Effluent Turbidimeters

An effluent turbidity meter shall be provided for each filter. Also, a total combined effluent turbidity meter shall be provided. The Turbidimeters shall be a HACH1720E. There shall be a total of five (5).

d. Filter Control Valves

The filter manufacturer shall supply Dezurik 150 lb. Class flanged butterfly valves (or approved equal) conforming to AWWA C-504. The valves shall be flanged with BUNA seats, 316 stainless steel shafts and cast iron bodies per ASTM A126. Shaft seals should be self-compensating split V-type or O-ring packing made of BUNA-N per AWWA C-504 Class B. The valves shall be supplied with Auma electric actuators. The actuators shall be housed in a double-sealed water tight enclosure and come complete with integral controls.

Description	Size	Operator	Qty.	Comment
Influent	12'	Electric	4	Open/Close
Effluent	8'	Electric	4	Open/Close I
Backwash Inlet	12"	Electric-	4	Open/Close
Backwash Waste	8»	Electric	4	Open/Close
Filter to Waste	12'	Electric	4	Open/Close
Air Inlet	6'	Electric	4	Open/Close
Air Vent	3"	Electric	1	Open/Close

### Filter Controls and Instrumentation

1. The contractor shall be responsible for installation of the filter control consoles and all wiring from the console to field devices, instruments, and other systems.
2. Instrument mounting brackets, pipe stands, etc., to be supplied by the installation contractor base specific site requirements.
3. Start-up shall be performed with all final elements, field devices, and instruments installed, calibrated, and wired in the circuit.

### Controls and Instrumentation Services

1. The control system manufacturer shall provide a technical representative to assist the contractor's personnel with the startup for not less than 15 days including travel time in 3 trips. The factory service technician shall have a minimum of five years experience in the start-up of air/water filter backwash systems.
2. On-site training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the hardware and to instruct them in day-to-day operations of the controls, preventative and regular maintenance, trouble shooting techniques, and system diagnostics.
3. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

### SPARES

Spares shall be provided as follows:

- Two (2) of each switch, push-button, light used.
- Two (2) of each type of relay used.
- One (1) of each type of PLC I/O card used.
- One (1 ) of each type of PLC power supply used;

END OF SECTION

### 1.0 GENERAL DESCRIPTION

#### A. Underdrain

1. The underdrain system for the filters shall be a dual parallel lateral type whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be so arranged that the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of air and water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures will not be considered acceptable. The primary chamber should provide at least 50 square inches (320 square cm) of cross sectional area per block to reduce flow velocity during backwash.
2. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty- three dispersion orifices per square foot of filter area. The orifices shall be not less than 7/32 inch (5.5 mm) diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch (3.2 mm). The top of each orifice shall be encircled by a depression approximately 3/8 inch (9.5 mm) x 3/4 inch (19 mm).
3. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.
4. A water recovery channel with return holes shall be incorporated into the top of the underdrain block to ensure uniform and continuous air flow from the top deck orifices and greater air stability. Underdrains without a water recovery channel will not be considered acceptable.
5. The secondary chambers of the underdrain shall have baffles sized and located to provide effective air control and to reduce level sensitivity. Underdrains without baffles will not be considered acceptable.

- B. Air Header
  - 1. Because the proper distribution of air into the underdrain has a significant effect upon operation, the filter manufacturer shall have the responsibility to design and provide the air distribution header for this underdrain.

## 2.0 PERFORMANCE AND DESIGN REQUIREMENTS

### A. General Requirements

- 1. The filter underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.
- 2. The underdrain system is intended to allow for the uniform collection of filtered water and uniform distribution of backwash water and air over the total area of the filter floor.
- 3. The backwash system shall allow for separate air scouring and water backwashing and for the simultaneous use of air and water at the specified rates.
- 4. The system shall be designed to avoid localized areas of excessive flow (maldistribution) which may cause mounding, lateral displacement, or other deleterious disturbances in the filter support media.
- 5. When subjected to a flow rate of 20 gpm/sf (48.9 m/h) of filter area the headloss through an underdrain lateral 40 feet (12.2 m) long shall not exceed 36 inches (910 mm) water column.
- 6. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches (510 mm) water column at a backwash flow rate of 20 gpm/sf (48.9 m/h) of filter area.

- B. Design Flow Rates: The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:

- 1. Downflow of filtered water up to 10 gpm/sf (24.5 m/h).
- 2. Upflow of backwash air at a rate in the range of 2 to 5 scfm/sf (36.6 to 91.5 m/h).

3. Upflow of backwash air, together with backwash water. Typical recommended combined air and water rates: 4 scfm/sf (73.2 m/h) and 5 gpm/sf (12.3 m/h). (Confirm other combinations with the factory).
  4. Upflow of backwash water up to 25 gpm/sf (61 m/h). (Contact the factory for higher rates).
- C. Flow Distribution: The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of air and water flows during backwash shall be as follows:
1. Lateral Water MD: The maldistribution in a lateral 40 feet (12.2 m) long or less shall not exceed +/- 3 percent of the average gpm/sf of filter for a backwash rate of 20 gpm/sf (48.9 m/h).
  2. Flume Water MD: Note, additional maldistribution, due to specific flume arrangement, entry conditions into both flume and underdrain laterals and flow velocities, must be considered.
  3. System Air MD: Visually, the air should show a uniform pattern.
- D. Structural Design Requirements
1. General: The filter underdrain system, including anchorage, supports, etc. shall be designed to safely withstand loadings for the specified conditions.
  2. Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 600 psf (28.7 kpa) or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of filter media.
  3. Downward Load: The filter underdrain system shall also be designed to withstand a net downward loading of not less than 2,500 psf (120 kPa).
- E. Air Temperature: During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200° F (93°C).

#### 1.0 MATERIALS AND CONSTRUCTION A. Underdrain

##### A. Underdrain

1. Material: The Individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces.
2. Dimensions: The block size and weight shall permit ease of handling and



installation. The block nominal dimensions shall be 12 inches (305 mm) high by 11 inches (279 mm) wide by 48 inches (1220 mm) long. The weight of the block shall be approximately 25 pounds (11 kg).

3. Block Geometry: The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout
4. Lateral Construction: The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be gasketed, bell and spigot type with internal alignment tabs for proper joint alignment, and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation of the laterals.
5. I.M.S®200: The I.M.S®200 media retainer shall be made of thermoplastic through the injection molded process and sealed to the top of the underdrain. The I.M.S®200 media retainer shall be made from two separate sections that are permanently sealed together to form slots or openings. The opening size shall be sufficient to prevent the media from obstructing or passing through the underdrain. Vertical baffles shall be located on the bottom side of the media retainer to “compartmentalize” the fluid to keep it from moving horizontally along the bottom side of the media retainer thus ensuring each pattern of slots in the media retainer receives equal quantities of air and or water during the backwash cycle. The I.M.S®200 media retainer shall replace the need for support gravel and shall not increase the underdrain height by more than 1 1/4 inch. The cap shall be attached and sealed to the underdrain at the factory using Type 316 stainless steel self-tapping screws and 3M Weatherban Sealant Tape.

B. Air Header

1. General: The air distribution system shall be generally comprised of a corrosion resistant header specially calibrated to evenly distribute air flow via properly located and sized pipes to each underdrain lateral. Sufficient relative velocities shall be maintained in both the header and distribution pipes to insure proper distribution of air.
2. Material: The air header piping shall be Sch 5, Type 304 stainless steel. The anchors and hardware for anchoring the air header shall be type 18-8 stainless steel.

C. Grout Retainer

1. Grout retaining strips for bridging flumes shall be of high-impact polystyrene properly keyed to fit the underdrain blocks to allow adjustment of lateral center-to-center distance without difficulty. Retaining strips shall be supplied by the filter manufacturer.

D. Grout

1. Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become lumpy shall not be used.
2. Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Water with a total dissolved solids of 1000 mg/l or higher or greater than 10 NTU shall not be used.
3. Sand: Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.
4. Chemical Admixtures: No chemical admixture is needed in most of the applications. The grout can be mixed in a small batch and used immediately.
5. Strength: The grout used in installing the blocks shall have a minimum compressive strength of 3000 psi (20684 kPa) after 30 days of curing. Normally, a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout.

E. Filter Media

1. A layer of silica sand filter media, at least 12" finished depth, after backwashing, scraping, and removal of fines, shall be placed on top of filter underdrain. The sand shall have an effective size of 0.45 mm to 0.55 mm, well rounded, not flat or angular, with a maximum uniformity coefficient of 1.50 or less. The hardness shall be 6 to 7 on the MOH scale and the specific gravity shall be 2.65 or greater. The hydrochloric acid solubility shall not exceed 5% when tested in accordance with AWWA Specification B1 GO- 89.

- 2 A layer of anthracite, at least 24" finished depth, after backwashing, scraping, and removal of fines, shall be placed on top of the filter media and gravel support layers. The anthracite shall have an effective size of 0.95 to 1.05 mm with a maximum uniformity coefficient of 1.4 or less. The hardness shall be not less than 2.7 on the MOH scale and the specific gravity shall be 1.4 or greater. The hydrochloric acid solubility shall not exceed 5% when tested in accordance with AWWA Specification B100-89.

#### 4.0 QUALITY ASSURANCE

- A. Manufacturer: The underdrain system for the filters shall be the Leopold Type S with I.M.S. Cap as manufactured by ITT Water & Wastewater, Leopold, Inc., Zelienople, Pennsylvania, or an Engineer approved equal.
- B. Experience: The underdrain system shall be a standard product of a filter manufacturer who has been actively providing dual-parallel lateral air/water underdrain equipment for at least 25 years. Upon request, the filter manufacturer will provide the ENGINEER with a list of installations of underdrain which totals not less than 200.
- C. NSF Certification: All materials used in contact with the water and backwash air shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects.
- D. Underdrain: The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining strips, closures, gaskets, etc., shall be the products of a single manufacturer/supplier.
- E. Hydraulic Demonstration
  1. The filter manufacturer shall, at their own facilities, if requested by the ENGINEER, set up a test lateral run of equal length to that required by the project and provide an opportunity for the ENGINEER and/or OWNER to visit the facility to witness a full scale demonstration of the headloss and flow distribution during backwash.
  2. The test facility shall be capable of demonstrating concurrent air and water distribution in a submerged trough and water only distribution on a non-submerged test bench.
  3. These demonstration services shall be provided by the filter manufacturer with reasonable notice and at no additional expense to the OWNER or ENGINEER.

5.0 INSTALLATION

A. Manufacturer's Services

1. The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 10 years of experience in the placement of underdrain. (Such persons shall be available on a fee-paid basis to instruct the CONTRACTOR in the proper placement and testing of the underdrain).
2. The CONTRACTOR shall provide the services of the manufacturer's technical representative for not less than ten (10) (the filter manufacturer shall provide in his scope to supply sufficient instruction to meet the requirement of one man-day per 300 square feet (28 square meters) of filter area or part thereof continuously installed) working days to inspect and supervise the installation and testing of the filter underdrain system in three (3) trips.
3. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

B. General

1. The CONTRACTOR shall install the filter underdrain system in strict accordance with: (1) the manufacturer's written—instructions and recommendations and the manufacturer's installation drawings; (2) the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the work; and (3) any additional requirements specified herein.

C. Floor Preparation

1. Care shall be exercised in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the drawing provided. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions, but have a rough, broom finish. Do not trowel or finish the floor to a smooth finish.

D. Underdrain Lateral Installation

1. The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the CONTRACTOR. After joining, aligning and setting the blocks, and the bed grout is set-up, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so that the entire bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least 3 full days before any functional testing.

**E Cleaning and Protection During Installation, Testing, and Startup**

1. The CONTRACTOR shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash air and water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the work shall be protected with heavy visqueen or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the support media is installed.
2. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with 1/2 inch (13 mm) minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

**6.0 FIELD TESTING**

**A. Underdrain Lateral Flow Distribution Test**

1. The filter underdrain system in each filter cell shall be given a series of visual, qualitative, flow distribution tests to verify that I.M.S. Cap pores are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the filter media is placed.
2. During each test, the underdrain laterals shall be visually inspected for uniform distribution of air and water and for any signs of quiescent zones and excessive surface turbulence.

**END OF SECTION**

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### A. General Rotary Blower Package

1. The use of a manufacturer's name and model number is for the purpose of establishing the standard of quality and general configuration desired. Products of other CE certified manufacturers will be considered in accordance with the General Conditions.
2. The blower package shall be manufactured by Kaeser Compressors, Inc., or an engineer approved equal, which meets all the requirements of this specification. Alternate blower selections must be shown on a List of Exceptions to the Specifications with itemized descriptions of how the selection differs from the specifications.
3. Nameplates stating the name of the manufacturer, blower/blower package model number, blower/blower package serial number, the rated capacity, speed, and other pertinent data, shall be attached to each blower/blower package.
4. Nameplates stating the name of the manufacturer, the motor model number, the motor serial number, the rated horsepower, speed, voltage, amps, rated service factor, and other pertinent data, shall be attached to the motor.

### B. Blower Type

The blowers shall be oil-free, positive displacement, rotary lobe type with three lobes per rotor, designed for air or other inert gas service, and belt-driven via electric motor.

### C. Casing

The casing shall be made of high strength, close grained, cast iron, and shall be adequately ribbed to prevent casing deflection and facilitate cooling. The casing shall be precision machined to allow for minimum clearances. Casing shall be of EN GJL 200 material with integrated pulsation-damping interference channels.

### D. Rotor Assemblies

The rotors shall be one piece casting EN GJS 500 material. The rotor design shall incorporate replaceable seal ring wear sleeves and be designed to carry loads that exceed those required at maximum design conditions. The rotor assemblies shall be statically and dynamically balanced to ISO standard 1940/1- Q2.5 (turbine rotor). The rotors shall be a tri-lobe design in order to minimize pulsation and noise.

## **E End Plates**

1. The gear-end plate shall be cast iron. The drive-end plate shall be integral to the blower casing. Bearing fits shall be precision machined to ensure accurate positioning of the rotors in the casing. Replaceable seal wear inserts shall be provided on the drive-end and gear- end plates.
2. The oil chamber covers shall be heavy-duty cast iron with a precision-machined sealing face. Aluminum oil covers are not allowed.

## **F. Timing Gears**

1. The rotor timing gears shall be precision machined from case hardened, ground alloy steel to quality standard 5f 21. Each timing gear shall be straight cut and beveled to eliminate axial bearing loads and ensure long life as well as quiet operation.
2. Each timing gear shall be manufactured in accordance with:
  - DIN 3960, Specifications for Spur Gear Sets
  - DIN 3961 & DIN 3962, Tolerances for Spur Gear Mesh
  - DIN 3964, Specifications for Shaft Centering
3. Gears shall be finish ground on a precision grinder to ensure concentricity. The timing gear set shall be taper-mounted on the rotors. Keyed, hub mounted, taper-pinned, or splined shaft timing gear mounting designs are not acceptable.

## **G. Bearings**

All four shaft support locations shall incorporate large, heavy-duty, full complement, cylindrical roller bearings with metal cages, designed with at least 5-times the dynamic capacity of ball bearings. The bearing maximum speeds must be at least two times the maximum recommended blower speed. The minimum acceptable **L10** design life at the blower's maximum rated speed and maximum rated differential pressure shall be 74,000 hours.

## **H. Lubrication**

Both the gear end and the drive end of the blowers shall be oil splash lubricated for minimal maintenance and long service life. Grease lubricated bearings are not acceptable. The lubrication design shall ensure adequate lubrication of the timing gears and bearings.

## **I. Seals**

1. There shall be four (4) piston ring type labyrinth seals at each end of each rotor to minimize leakage and maintenance costs.
2. A vent cavity shall be provided between the air side and oil side rotor shaft seals on all four (4) sets of piston ring type labyrinth seals. The two (2) vent holes located on the bottom side of the blower shall be left open. The vent holes at other locations shall be closed off with threaded metal plugs.
3. The input drive shaft seal shall be a high temperature radial lip type seal with Viton

elastomers. The seal design shall incorporate a replaceable wear sleeve on the input drive shaft.

4. The input shaft seal design must allow for the lip seal and the shaft sleeve to be replaced without removing the oil chamber shaft.

#### **J. Drive Motors**

1. Drive motors shall be designed, manufactured, and tested in accordance with the latest revised editions of NEMA MG-1, IEC, IEEE, ANSI, and AFBMMA standards as applicable and shall be capable of continuous operation.
2. Motor must meet or exceed Energy Independence and Security Act (EISA 2007) standards for motor efficiency.
3. The motor nameplate horsepower rating shall not be exceeded at the design speed.
4. The temperature rise of the motor windings shall not exceed IEC and NEMA standards when the motor is operated continuously at the rated horsepower, rated voltage, and rated frequency in ambient conditions of 40°C / 104°F.
5. The motors shall conform to the following:

<b>Mounting:</b>	Horizontal
<b>Type:</b>	Squirrel Cage Induction.
<b>Enclosure:</b>	TEFC
<b>Service Factor:</b>	1.15
<b>Duty Cycle:</b>	Continuous
<b>Ambient Temperature Rating:</b>	40°C/104°F
<b>Starting Current:</b>	6-1 OX Full Load Current Maximum
<b>Winding Insulation:</b>	Class F
<b>Temperature Rise:</b>	Class B
<b>Voltage/Phase/Frequency</b>	208,230, or 460V/3ph/60Hz
<b>Bearing Lubrication:</b>	Grease
<b>Maximum Speed:</b>	3,600 rpm
<b>Speeds:</b>	Single Speed
<b>Motor Protection:</b>	PTC Thermistors

#### **K. Drive**

1. The packages shall be driven through V-belts and sheaves with SPZ or SPB profile. The drive assembly shall be of the high capacity type, oil and heat resistant, with a 1.5 safety factor.
2. Automatic tensioning of the V-belts by use of a pivoting, swing frame motor base, with adjustable spring assistance and visual indication of V-belt tension, shall be provided to ensure the V-belts remain properly tensioned with minimal maintenance and to extend V- belt, sheave, and bearing life. Adjustment of the tensioning device shall be



accomplished without removal of the guard or loosening of the motor mounting bolts. The drive guard shall be the manufacturer's standard sheet metal with provision for ventilation. The installed guard shall be fully-enclosed and designed to meet current OSHA standards.

3. Belt shall be 100% oil-resistant.

#### **L. Standard Blower Gauges**

1. A pressure gauge shall be provided, pre-piped and panel mounted, on the sound enclosure.
2. A temperature gauge, with adjustable switching point and contact, shall be provided pre-piped and panel mounted on the sound enclosure (wiring of switch by others).
3. A filter differential pressure gauge shall be provided pre-piped and panel mounted on the sound enclosure.

#### **M. Enclosure**

1. A sound enclosure shall be provided. The sound enclosure shall be sheet steel construction with a "powder coat" type paint finish, which shall be durable and scratch resistant.
2. To prevent transmission of vibration and noise, the legs of the base shall include vibration isolators made of rubber in a steel footing equipped with mounting holes for securing the package to the enclosure bottom.
3. All access panels/doors shall have slotted key locks or handles. A door key shall be provided.
4. At least one installed, integral ventilation fan, sized to provide adequate cooling of the package, shall be provided (wiring of fan by others). The desired fan voltage should be specified (115V/1Ph or 3Ph-main motor voltage). If not specified, fan voltage will be 115V/1 Ph/60Hz. The fan should run congruent to blower.
5. The blower package shall be capable of being installed directly adjacent to another blower packages of similar design and shall be capable of mounting next to the wall without maintenance interference.
6. Stainless steel weather hoods shall be made available for units that are installed outdoors.

#### **N. Blower Package**

1. The inlet filter shall be integral to the inlet silencer and shall include a washable and reusable polyester element for minimal pressure drop. Air filtration shall be to EN 779, Class G4.
2. The inlet silencer shall be of the wear-free absorptive type, directly connected to the inlet port of the blower, and shall be mounted horizontally.
3. The discharge silencer shall be designed specifically for all frequency ranges of the blower to maximize attenuation and shall use a combination of absorption, reflection, and diffusion.

The silencer shall be directly connected to the outlet port of the blower. The discharge

silencer shall be mounted horizontally and shall be integral to the base frame.

4. Oil drains from the blower drive-end and gear-end lubricating oil sumps shall be piped to the front of the base for ease of maintenance. The drain valves shall be a ball valve with a fully retained and gasketed threaded cap.
5. The relief valve shall be spring loaded and factory installed in a location to protect the blower from excessive discharge pressure or vacuum. The relief valve shall be mounted integrally to the blower package.

#### **O. Piping**

An elastomeric compensator/flex connector shall be provided for connection of the packaged blower to the system piping to reduce transmission of structure borne noise as well as prevent unacceptable loading of the silencer connection and blower casing. On packages with tube outlets (4" and below) the compensator shall be hose-type. On packages with outlets larger than 4", the compensator shall be arch-type, flanged with both ANSI125/150 lbs. and DIN PN10 bolting patterns.

#### **P. Testing and Inspection**

1. Parts must be inspected as part of a strict ISO 9001:2008 quality control program.
2. All critical dimensions of the blower components provided by the manufacturer shall be verified and documented prior to assembly
3. The rotating parts of each blower actually provided by the manufacturer shall be statically and dynamically balanced before final assembly. The blower alone shall operate without excessive vibration. Removal of material from the face of the rotors for balancing purposes is not acceptable.
4. Each blower provided by the manufacturer shall be slip tested (per ISO 1217).
5. Each blower provided by the manufacturer shall be operated at its maximum rated speed and differential pressure for thirty (30) minutes.
6. On completion of final assembly of the packaged blower and prior to shipment, each packaged blower shall be mechanically run for a minimum of fifteen (15) minutes.

#### **L. Quality Assurance**

1. All blowers and equipment covered by this specification are intended to be standard blower equipment, of proven ability, as manufactured by a reputable CE certified manufacturer having at least two (2) years experience in the production of such blowers. The blowers furnished shall be designed, constructed, and installed in accordance with the best practice and methods and shall operate satisfactorily when installed.
2. All equipment furnished under this specification shall be unused, and shall be the standard product of a manufacturer having a successful record of manufacturing and servicing the equipment and systems specified herein for a minimum of two (2) years.

#### **R. Standard Limited Warranty**

1. The manufacturer and contractor shall warrant the blower being supplied to the owner

against all defects in workmanship and materials for a period of sixty (60) months from date of shipment from the manufacturer of the blowers. All other package components shall be warranted for a period of twelve (12) months from date of startup, not to exceed eighteen (18) months from the date of shipment.

2. The manufacturer's warranty period shall run concurrently with the contractor's warranty period. No exception to this provision shall be allowed. The contractor shall be responsible for proper storage of the equipment so as to remain in "as shipped" condition. If the equipment remains in storage at the job site for longer than six (6) months before installation, the contractor shall provide factory service personnel for a complete inspection of the equipment. Any work necessary to restore the equipment to "as shipped" condition shall be the responsibility of the contractor.

## S. Specific Details

<b>Installation Location:</b>	Adjacent to Filters
<b>Blower Manufacturer:</b>	Kaeser Compressors, Inc. (or Engineer Approved Equal)
<b>Blower Package Model:</b>	DB 236 C pr
<b>Quantity:</b>	One (1)
<b>Operation Protocol:</b>	Constant Speed
<b>Motor Horse Power</b>	25 Horse Power
<b>Power Supply Voltage</b>	208 VAC
<b>Estimated Blower Package Noise Level:</b>	dB(A) at 3 feet* ;

In accordance with ISO 2151 and ISO 9614-2

## T. Service Conditions and Performance Requirements

<b>Standard Conditions</b>			
<b>Elevation:</b>	1102 Ft. A.S.L.	<b>Gas:</b>	Air
<b>Ambient Pressure:</b>	14.7 psia	<b>K-Value:</b>	1.395
<b>Ambient Temperature:</b>	68 °F	<b>Specific Gravity:</b>	1.000
<b>Relative Humidity:</b>	0%	<b>Molecular Weight:</b>	28.966

END OF SECTION

Part 1 – General

1.01 Description

- A. Pumps shall be positive displacement peristaltic type complete with spring-loaded pumphead, self-contained variable speed drive, and flexible extruded tube as specified.
- B. Peristaltic pumping action is created by the compression of the (flexible tube between the pumphead rollers and track, induced forward fluid displacement within the tube by the rotation of the pump rotor, and subsequent vacuum- creating restitution of the tube.
- C. Pumps shall be dry self-priming, capable of being run dry without damaging effects to pump or tube, and shall have a maximum suction lift capability of up to 30' vertical water column. Maximum pressure rating: 50 psi. with the 520DuS/R2 & 60 psi with the 620DuS7RE.
- D. Pump shall not-use check valves or diaphragms and shall not require dynamic seals in contact with the pumped fluid. Process fluid shall be contained within pump tubing and shall not directly contact any rotary or metallic components.
- E. Flow shall be in the direction of the rotor rotation, which can be reversed and shall be proportional to rotor speed.

1.02 Quality Assurance

- A. This specification is the basis for design of peristaltic metering pumps. All pumps, whether named as an acceptable supplier or submitted; as an equal must, at a minimum, meet the following critical design requirements.
  - B. To maximize pump efficiency and minimize tube fatigue that will impact life, performance, and accuracy, pumps must be designed not to exceed the specified P/10 ratio (Theoretical maximum number of occlusions per 10 gallons pumped). Pumps exceeding the specified P/10 ratio will not be considered suitable for the duty condition. The following criteria is set to maintain the P/10 of ratio for the tube size specified for this application:
    - 1. Maximum two compressing rollers for two compressions per revolution.
    - 2. Tube wall thickness of 2.4 mm for the 520R2 pumphead & 4.0mm for the 620RE pumphead.
    - 3. Large diameter spring-loaded roller set for 2.4mm wall thickness tubing on the 520R2 pumphead and 4.0mm wall thickness on the 620RE pumphead.

4. Max base drive speed of 220 RPM for the 520DuS/R2 with 2.4mm wall thickness tubing. Max base drive speed of 265 RPM for the 620DuS/RE with 4.0mm wall thickness tubing.
  5. Track geometry of no less than 180 degrees and rotor geometry with roller 180 degrees apart.
- C. P/10 ratio shall not exceed the following per tube size:
1. 520DuS/R2

Tube Size		P/10 ratio
1.6mm	x 2.4mm	181,820
3.2mm	x 2.4mm	45,460
4.8mm	x 2.4mm	20,840
6.4mm	x 2.4mm	11,570
8.0mm	x 2.4mm	7,170

- 2 620DuS/RE
- | Tube Size      | P/10 ratio |
|----------------|------------|
| 12.0mm x 4.0mm | 2,054      |
| 17.0mm x 4.0mm | 1,284      |

- D. For quality assurance, all pump tubing must be manufactured by the pump manufacturer in accordance with their specifications. Tubing not manufactured by the pump manufacturer will not be acceptable.
- E. For chemical compatibility with a broad spectrum of chemicals, the pump housing shall have powder coating per 2.03.C.5.
- F. Drive and pump heads shall be 24 hr continuous duty rated and have a three- year manufacturer's warranty from date of shipment.
- G. Pumps to be manufacturer's standard product. Manufacturer of tubing pumps must have at least 20 operating installations in domestic water or wastewater treatment plants located in the United States over a period of at least seven years in the same service and size as specified.
- H. Pumps must be manufactured under ISO 9001-2000.
- I. Pumps shall be meet all applicable CE and C ETL US standards per UL610101A .

### 1.03 Submittals

- A. Submit the following
  1. Certified shop drawings.
  2. Characteristic performance curve showing flow rate as a function of RPM and pressure.
  3. Dimensional drawings.
  4. Operating, maintenance, programming, and wiring instructions
  5. P/10 ratio calculation.

#### 1.04 Delivery, Storage, & Handling

##### A. Shipping

- 1 Ship pump and drive assembled complete. Ship tubing separately for field installation and process line connection by contractor.
- 2 Pack all additional spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended.
- 3 Deliver spare parts at the same time as pertaining equipment.

##### B Receiving

Contractor to inspect and inventory items upon delivery to site. I Contractor to store and safeguard equipment, material, instructions, and spare parts in accordance with manufacturer's written instruction

#### Part 2 - Pump Design

##### 2.01 Manufacturer:

- A. Watson-Mariow Inc or an engineer approved equal.

##### 2.02 Pump Process Schedule

A.

Quantity	8					
Tag Number(s)						
Fluid Viscosity Specific Gravity Fluid Temperature	<b>Caustic (2), Fluoride (2), Phosphate 2), Sodium Permanganate (2).</b>					
Tubing Material	Marprene II					
Max - Min Capacity (G PH)	24 GPH (Max). 3 GPH (Ava)					
Max Pump RPM for Application	100 rpm I					
Tubing ID	1.6mm	3.2mm	4.8mm	6.4mrjr	8.0mm	9.6mm
Displacement /Revolution (Gallons)	0.0001	0.0004	0.0010	0.0017	0.0028	0.0040
Displacement /Revolution (Milliliters)	0.38	1.51	3.79	6.43	10.60	15.14
P10 Ratio (Theoretical Maximum Number of Occlusions/10 Gallons Pumped)	181,820	45,460	20,840	11,570	7,170	4,960
Min Flow Rate (GPH)	0.0007	0.0027	0.0058	0.0104	0.0167	0.0242
Max Flow Rate (GPH)	1.52	5.83	12.68	22.83	36.78	53.26
Min Flow Rate (MI/Min) _____	0.04	0.17	0.38	0.67!	1.10	1.50

Max Flow Rate (MI/Min)	92 370 830 1500 2300 3300
Max Discharge Pressure (PSI)	<b>Less than 50 psi for Caustic, Fluoride and Caustic Pumps. Greater than 225 psi for Sodium Permanganate Pumps at Intake.</b>
Suction Head	<b>Flooded</b>
Power (VAC, Frequency, Phase)	115VAC, 60 Hz, 1 Phase

## B. 620DuS/RE

Quantity	<b>3</b>	
Tag Numbers)		
Fluid Viscosity Specific Gravity Fluid Temperature	<b>Sodium Hypochlorite (3)</b>	
Tubing Material	Marprene II	
Max - Min Capacity (GPH)	<b>52 GPH (max), 21 GPH (avg)</b>	
Max Pump RPM for Application	<b>60 rpm</b>	
Tubing ID	12mm	17mm
Displacement /Revolution (Gallons)	0.00974	0.01558
Displacement /Revolution (Liters)	0.037	0.059
P10 Ratio (Theoretical Maximum Number of Occlusions/10 Gallons Pumped)	2,054	1,284
Min Flow Rate (GPM)	0.0010	0.0016
Max Flow Rate (GPM)	2.58	4.13
Min Flow Rate (LPM)	0.0037	0.0059
Max Flow Rate (LPM)	9.81	15.64
Max Discharge Pressure (PSI)	<b>Less than 50 psi</b>	
Suction Head	<b>Flooded</b>	
Power (VAC, Frequency, Phase)	115VAC, 60 Hz, 1 Phase	

## 2.1 Pump Construction

### Pumphead

#### 1. 520R2 Pumphead

- a. Pumphead shall consist of a fixed track, a hinged guard door, two spring-loaded tube clamp mechanisms, and spring-loaded roller rotor assembly. Pump tubing shall be in contact with the inside diameter of the track through an angle of 180 degrees and be held in place on the suction and discharge by a spring loaded self-adjusting clamp mechanism. At all times, one roller shall be fully engaged with the tubing providing complete compression and



preventing back flow or siphoning. Tube occlusion and spring tension shall be factory set to accommodate 2.4mm wall thickness tubing and shall not require adjustment for accommodating tubing of 1.6mm to 9.6mm ID.

b. Pumphead Assembly

- 1) Pump Track Geometry must have a minimum 96.6mm swept diameter through a minimum track angle of 180 degrees
- 2) Provide high corrosion/impact materials as specified
  - a) Track Construction: polyphenylene sulfide (PPS)
  - b) Guard Construction: hinged impact-resistant polycarbonate breakaway guard, tool un-lockable for operator safety.
  - c) Rotor Construction: polyphenylene sulfide (PPS)

c. Tube Retainer Mechanism

- 1) Provide two spring-loaded adjustable tube retainer mechanism to secure the tubing at the entry and exit points of the pumphead

d. Rotor Assembly

- 1) Provide rotor assembly that ensures gradual tube occlusion and compensates for tube tolerance:
  - a) Twin spring-loaded roller arms located 180 degrees apart, each fitted with stainless steel helical springs and compressing roller for occlusion of the tube twice per rotor revolution
    - 1) Compressing Rollers: 316SS with low friction stainless steel bearings and PTFE seals, minimum diameter of 18mm
  - b) Provide non-compressing guide rollers constructed of Corrosion resistant Nylatron
- 2) Clutch: Equip rotor with a central handgrip hub and manually activated clutch to disengage the rotor from the drive for manual rotor rotation during tube loading. Clutch shall automatically reengage rotor to gearbox upon one complete revolution.
- 3) Mounting: To prevent slip, the rotor assembly shall be axially secured to the dogged output shaft of the gearmotor via a slotted collet and central retaining screw.!
- 4) Pumpheads requiring disassembly or special tools for tube changing are not acceptable.

2 620RE Pumphead

- a. Pumphead shall consist of a fixed track with tool lockable-hinged guard door and magnetic safety interlock, which shall render the drive inoperable when the pump door is open. For operator safety, pumps without lockable guard, safety interlock, and/or flip-top design pump heads are not acceptable.

- b. Pumphead door shall have two clear windows for viewing of rotation direction. When closed, pump door shall seal against the pump track for leak containment and controlled waste through the pumphead waste port in the event of a tube failure. For operator and environmental safety, pumps without clear viewing windows and/or waste port are not acceptable.
- c. Rotor assembly shall be equipped with two compression rollers, which shall be retractable for tube loading, SIP, or CIP flushing cycles. Compression rollers shall be located 180 degrees apart for compression of the tube against the track twice per rotor revolution. One roller shall at all times be fully engaged with the tubing providing complete compression to prevent backflow or siphoning. Occlusion gap shall come factory set to accommodate 4.0 mm wall thickness tube. To maximize pump efficiency, pumps without retractable rollers and/or more than 2 compressing rollers are not acceptable.
- d. The rotor assembly shall be close coupled to the output shaft of the drive gear motor by a 19 mm keyed shaft and shall be axially secured to the shaft by a through center retaining screw. Pumphead track shall be secured to the drive via two slotted screws and shall be self-locating.
- e. Material of Construction
  - 1) Track: Aluminum, Trimite polyester powder coat, electrostatic ally applied and baked
  - 2) Door:
    - a) Inner Shell: Grilamid TR55
    - b) Outer Shell: shock resistant Polyurethane
    - c) Door Seal: Silicone
    - d) Drain Port Adapter: Acetyl
  - 3) Rotor:
    - a) Hub & Roller Arms: Fortran 1140L4 (PPS)
    - b) Hub Cover. Dupont Hytrel G5544
    - c) Main Rollers: 304SS
    - d) Main Roller Bearings: Carbon Steel (sealed)
    - e) Guide Rollers: Nylatron
    - f) Hardware & leaf springs: 304SS

## B Tubing

- 1. Continuous Tubing for 520R2 Pumphead
  - a. Pump tubing shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by tube retainer clamps. The tubing shall be replaceable without the use of tools and with no pumphead. To achieve maximum flow per revolution, p ump heads with a track angle of less than 180 degrees are not acceptable! See 1.02.

- b. Pump tubing shall be constructed of Marprene II, a thermoplastic elastomer with a 64 Shore A durometer and 2.4mm wall thickness. Pump manufacturer must manufacture Marprene tubing in-house. Pump manufacturers who purchase third party tubing are not acceptable.
  - c. Pump shall readily accept tubing ID's of 1.6mm, 3.2mm, 4.8mm, 6.4mm, 8.0mm or 9.6mm without pump adjustment or replacement. Tubing with a wall thickness less than 2.4mm is not acceptable. See 1.02.
  - d. Supply 15-meter roll of specified tubing size.
2. Load Sure Elements for 620RE Pumphead
- a. Pump shall be supplied with a Load Sure tubing element with molded fittings, which shall be self-locating when fitted into the pumphead. Tube element shall be in contact with the inside diameter of the track (housing) through an angle of 180 degrees and be held in place on the suction and discharge by the element fittings. The tubing shall be replaceable without the use of tools and with no disassembly of the pumphead. To achieve maximum service life, pump heads with a track angle of less than 180 degrees and/or without tube elements are not acceptable. See 1.02.
  - b. Pump tubing shall be constructed of Marprene II, a thermoplastic elastomer with a 64 Shore A durometer and 4.0mm wall thickness. Pump manufacturer must manufacture Marprene tubing in-house. Pump manufacturers who purchase third party tubing are not acceptable.
  - c. Pump shall readily accept tubing elements with ID's of 12.0mm and 17.0mm without pump adjustment or replacement. Tubing with a wall thickness less than 4.0mm is not acceptable. See 1.02.
  - d. Molded Fittings: Polypropylene, 3/4" Male Cam & Groove
  - e. Supply Four (4) tube elements of the specified size per pump.
  - f. Supply Three (3) meters of reinforced transparent PVC flexible hose for connection of pump to suction and discharge process lines. Flexible hose shall have a Polypropylene female cam & groove fitting for mounting to pump and 3/4" male cam and groove fitting for mounting to process piping.
- C Drive
- 1. Rating: Continuous 24 hour operation, 400 C ambient.
  - 2. Supply: 1 10-120V 50/60 Hz, 1-Phase field. Supply a 6-foot length mains power cord with standard 115V three-prong plug.
  - 3. Max drive power consumption: 135VA for the 520DuS/R2 & 250 VA for the 620DuS/RE
  - 4. Enclosure: NEMA 4X
  - 5. Housing: Pressure cast aluminum with Alocrom pre-treatment and exterior grade corrosion resistant polyester powder coat. By nature of the environmental conditions, unpainted housings, including 316SS, are not acceptable.

- 6 Pumps must meet the following minimum requirements for operator interface functionality. Pumps not meeting this minimum functionality will not be accepted.
  - a. Backlit graphical LCD capable of up to four lines of text with up to 16 characters per line to display pump speed, running status, flow rate, and programming instructions
  - b. Keypad for start, stop, speed increment, speed decrement, forward/reverse direction, rapid prime, and programming.
  - c. Menu driven on screen programming of manual or auto control, flow and remote signal calibration, and general programming.
  - d. Programmable "Auto Restart" feature to resume pump status in the event of power outage interruption.
  - e. Programmable "Keypad Lock" to allow operator lockout of all keys except emergency start/stop.
  - f. Programmable "Maximum Speed" to allow operator to set the maximum speed of the pump within 0.1-220 rpm on the 520DuS/R2 and between 0.1-265 rpm on the 620DuS/RE.
- 7 Supply auto control features to meet the following minimum functionality requirements for use with the SCADA system. Pumps not meeting this minimum functionality will not be accepted.
  - a. Remote Control Inputs
    1. Speed Control:
      - a) Primary Analog 4-20mA or 0-10VDC speed input, with input signal trimmable and speed scaleable over any part of the drive speed range.
      - b) Secondary Analog 4-20mA or 0-10VDC scaling input, with input signal trimmable and programmable scaling factor.
      - c) Provisions for alternative remote accessory potentiometer (if supplied by others) for primary speed control or secondary speed scaling.
    1. Start/Stop Control: via 120 VAC input- Configurable command sense allowing open to equal run or open to equal stopped.
    2. Forward/Reverse Control: via 120 VAC input
    3. Auto/Man Mode Control: via 120 VAC input
    4. Leak Detector Run/Stop Control:
  - b. Status Outputs
    1. Four relay contacts rated for a max current of 2A at 120V, NO or NC software configurable to indicate the following:
      - a) Running/Stopped status
      - b) Forward/Reverse status
      - c) Auto/Manual status
      - d) General Alarm status

- e) Leak Detected status
- 2. Speed output-Analog 4-20mA or 0-10 VDC i
- c. Accepts RS485 data protocol
- d. Termination: supply screw down terminals suitable for up to 18 AWG field wire and accessible through four glanded cable entry points on the pump
- 8 Drive motor- brushless DC motor with integral gearbox and tachometer feedback.
  - a. Speed Control Range of 2200:1 from 0.1 to 220 rpm +/- 0.1 rpm throughout the range for the 520DuS/R2. Speed Control Range of 2650:1 from 0.1 to 265 rpm +/- 0.1 rpm throughout the range for the 620DuS/RE
  - b. Closed loop microprocessor controlled drive with pulse width modulation at speeds above 35 rpm and synchronous mode with magnetic field rotation control below 35 rpm
  - c. Circuitry complete with temperature and load compensation and protection.
- 9 Mounting: Drive shall be self-supporting and shall not require anchoring.
- 10 Leak Detection
  - a. 520DUS/R2
    - 1. Factory-mount a capacitance type tube monitor directly under the pump head, which shall shut the pump down in the event of a detected leak. Capacitance sensor shall be equipped with a sensitivity adjustment, reset pushbutton, and fault indicator LED
  - b. 620DuS/RE
    - 1. Pump manufacturer shall supply float-type leak sensor mounted to the drain port of the pump head for leak detection and pump shut down in the event of a tubing failure

#### D Spares

- 1. Supply one spare pump head assembly for each size pump.

#### E Skid-Mounting

- 1. Each application shall require a two pump, skid mounted design. The sodium hypochlorite skid shall consist of three pumps. This shall include the pumps, skid, interconnecting piping, graduated cylinder (2,000 ml for all chemicals except 5,000 ml for sodium hypochlorite), isolation valves, and any ancillaries providing a complete system capable of only wiring and piping terminations in the field. Skid shall be constructed of polypropylene.

## F Tubing

- 1 Tubing shall be supplied as follows: Pump supplier shall provide 9.6 mm (ferrie) and 6.4 mm (caustic, fluoride, polymer, phosphate and sodium permanganate. Tubing material shall be Marprene and have characteristics as described in previous table within this specification. One 50' roll of 9.6 mm tubing and two 50' rolls of 6.4 mm tubing shall be provided. For the sodium hypochlorite, 17.4 mm element style tubing shall be provided. Tubing material shall be Marprene and have characteristics as described in previous table within this specification.

## Part 3 - Execution

### 3.1 Installation (By Contractor)

- A. Contractor shall install items in accordance with manufacturer's printed instructions and as indicated and specified.
- B. Contractor to supply fittings for connection of pump to process.
- C. Contractor shall supply shielded signal wiring for wiring of the required remote input and output to the connectors.

END OF SECTION

### PART1GENERAL

- 1.1 Furnish and install at the location shown on the drawings two (2) 5,000 gallon tanks for the storage of bulk liquid ferric and caustic. The tanks shall be Type 2 High Density Linear Polyethylene designed for the storage of liquid ferric and caustic. The tanks shall be furnished complete with fill nozzle, vent, vented manway, and related accessories as shown on the drawings or as necessary to complete to project.
- 1.2 ACTIFLOW CARB: Furnish and install at the location shown on the drawings five (5) 120 gallon day tanks for the storage of chlorine bleach, caustic, phosphate, and fluoride at the Water Treatment Plant, the tanks shall be constructed of HDPE. The tank shall be furnished complete with 14" PE Threaded-Vented Fill cap w/11-3/8" access and related accessories as shown on the drawings or as necessary to complete the project.
- 1.3 Refer to other sections for work related to that specified under this heading.

### PART 2. PRODUCTS

#### 2.1 Ferric and Caustic Tanks

- A. Two tanks shall be installed at the Water Treatment Plant, one each for Ferric and Caustic. The tanks shall be 5,000 gallons nominal capacity approximately 102-inches (8.50-feet) inside diameter by 152-inches (12.67-feet) in height with an arched top and suitable for storing liquid ferric and caustic.

- B. The tank walls shall be 3/8-inch minimum thickness throughout or as recommended by the manufacturer.
  - C. The tank shall have a single 24-inch manway with flanged bolt-on covers as shown on drawings.
  - D. The fill line, dome/top vent, and discharge shall be approximately six (6) inches in length with joint suitable for connecting piping and shall be two (2) inches welded flange. The flanges are to be ASA 125 lb. or as recommended by the manufacturer.
  - E. The level control shall also be approximately six (6) inches in length with joint suitable for connecting piping and shall be four (4) inches welded flange. The flange shall be ASA 125 lb. Or as recommended by the manufacturer.
  - F. Tanks shall be of Type 2 High-Density Linear Polyethylene or equal.
  - G. The 5,000 gallon bulk storage tanks shall be as manufactured by IMG, Corporation, Memphis, -TN- or an approved equal and recommended for intended use. The manufacturer of the tank shall submit a certified letter to this effect for each tank and subject chemical.
- 
- 2.2 The bulk ferric and caustic storage tanks shall have a certification label stating the name of the corrosion resistant material type of reinforcement, chemical to be stored (including concentrations specific gravity, and maximum temperature), the name of the exterior resin, tank capacity, and date of manufacture.
  - 2.3 The bulk storage tanks shall be furnished with a gauge to indicate tank volume by large black numerals on a bright yellow background on the sight glass at 500-gallon intervals.
  - 2.4 The bulk storage tanks as provided under this section shall be suitable for the indoor storage of the specified chemicals. The manufacturer of each tank shall submit a certified letter to this effect.
  - 2.5 The bulk storage tanks shall be equipped with a level indicator that will provide a 420 mA output to be connected to the SCADA system as to allow the operator to determine the actual tank levels through the SCADA system. The internal level transmitters shall be resistant to the chemical being stored. Written certification from the tank manufacturer shall be submitted to the A/E indicating the level transmitters/indicators are designed for use in such chemicals (along with technical data) prior to installation into the tanks for review and approval.



- 2.6 Provide and install tie down lugs and all other accessories as required for a complete installation of the bulk storage tanks
- 2.7 The 120 gallon storage tanks shall be as manufactured by Snyder Industries incorporated, or an engineer approved equal and recommended for intended use. The manufacturer of the tank shall submit a certified letter to this effect for each tank and subject chemical.
- 2.8 The tanks shall be approximately 33" in diameter and approximately 46" from the base of the tank to the fill line.
- 2.9 The 120 gallon day tanks shall be equipped with a level indicator that will provide a 4-20 mA output to be connected to the SCADA system as to allow the operator to determine the actual tank levels through the SCADA system. The internal level transmitters shall be resistant to the chemical being stored. Written certification from the tank manufacturer shall be submitted to the A/E indicating the level transmitters/indicators are designed for use in such chemicals (along with technical data) prior to installation into the tanks for review and approval.
- 2.10 Each of the storage tanks as provided under this section shall be suitable for the indoor storage of the particular chemical that they are to be storing. The manufacturer of the tank shall submit a certified letter to this effect for each tank and subject chemical (i.e. chlorine, sodium permanganate, phosphate, polymer, fluoride, caustic, and ferric).

### PART 3. EXECUTION

#### 3.1 INSTALLATION

- A. Upon delivery, check tanks closely for damage. Ensure that tanks are handled with care to prevent inadvertent damage during installation.
- B. Install the tanks according to the manufacturer's instructions.
- C. Install the tanks on a stable foundation having sufficient load bearing characteristics and providing smooth continuous full bottom support.
- D. Do not grout under the tanks.

### 3.2 HYDROSTATIC TESTING

- A. After tank has been installed and before piping connections is made and equipment attached, block outlets and fill straight shell portion with chemically compatible fluid.

### 3.3 CLEANING

- A. After installation is completed and piping connections are made, clean tank and nozzles with a mild soap solution and rinse with 180 degrees F water.

END OF SECTION

### PART 1. GENERAL

- A. Dosing amount is for 3 MGD at 6 ppm (40 gr./minute). The injection point is 125 feet horizontal and 20 feet Vertical.
- B. The PAC System shall be as manufactured by Con-V-Air Solutions or an engineer approved equal.

### PART 2. SYSTEM DESCRIPTION

- A. The system is designed to allow for the operator to empty bags (approximate 25 kg per bag) into the manual bag dump station and have the PAC feed into the wetting cone as needed. The amount of PAC to be fed into the wetting cone shall be determined based on the plant feedback (by others) and the system will automatically adjust the PAC feed rate accordingly.
- B. Once wetted the PAC slurry shall be conveyed using the supplied hydro ejector system. PAC slurry make-down is initiated by a signal from the Owner's PLC. Upon receiving the signal the water supply shall open and the feeder shall start. The carbon and water will be combined in the wetting cone and discharged by the hydro ejector to the point of use. Should anything downstream of the wetting cone clog, the water liquid level detector, located in the wetting cone, will sense the liquid and in turn stop the screw feeder, close the water inlet valve and signal an alarm. This alarm state will stay active until such time as the operator presses the reset button.
- C. It is to note that all equipment provided **WITH THE EXCEPTION OF THE CONTROL PANEL** will be for Class II Division II classification. The control panel will have to be installed on the outside wall beyond the Class II Division II area. Use NEMA 4X Stainless Steel cabinet to house the control panel.

## **PART 3      EQUIPMENT DESCRIPTION**

3.1    It is a PAC injection system for small bags (25 kg). The system takes 25 kg bags of PAC and prepares a continuous solution.

A.    Screw Feeder system complete with:

1.    304 SS feed screw with discharge and downspout;
2.    0,625" diameter screw;
3.    3 ft<sup>3</sup> 304 stainless steel hopper;
4.    SS cover with inlet;
5.    One electric vibrator 1/6 Hp at 120VAC single phase;
6.    One reducer with a **A** Hp 90VDC variable speed motor;
7.    Level Sensors;
8.    Use 12 AWG wire size for the motor.

B.    Wetting Cone and ejection system complete with:

1.    304 stainless steel wetting cone;
2.    One water inlet connection;
3.    One connection for overflow;
4.    One flange for connection to the volumetric feeder outlet;
5.    One connection to install the solution ejector;
6.    One needle valve to adjust water flow at wetting cone inlet;
7.    One solenoid valve for water inlet on/off operation;
8.    One liquid conveying ejector for solution transfer.

C. Hydro-ejector

1. One brass construction hydro-ejector to transfer pre-wetted PAC from cone to point of application. The' ejection come complete with:
  - a. Manually operated brass isolation ball valve
  - b. Solenoid valve
  - c. Inlet pressure Indicator

D. Control Panel to operate the system parameters. The control panel will include:

1. Potentiometer for calibration purposes;
2. 4-20 mA input Card (4-20mA signal by others);
3. Selector switch for manual/off/Auto operation;
4. Reset button in case of system liquid overflow;
5. Pilot lights;
6. SCR for feed rate control.

It is to note that the control panels shall have to be installed outside the Class II Division II environment and will have to field wired by a local certified electrician. Also, the 4-20mA control signal is by others.

PART 4. MISCELLANEOUS REQUIREMENTS,

A. Utilities

1. Water: 140 liters/minute at 60 psi
2. Electricity: 3 kW
3. Instrument AIR: 1 CFM

B. The equipment provider shall provide 2 days of start-up assistance.

~~C—Mechanical and electrical installation shall be provided by the contractor.~~

END OF SECTION

### PART 1. GENERAL

#### 1.1 WORK DESCRIPTION

This section of the specifications and related drawings describe requirements pertaining to general casework and laboratory furniture applications. The extent of the casework is shown in the drawings. The type of casework required is described in this section of the specifications. In order to establish equipment designs for a project, the catalog numbers of COLLEGEDALE CASEWORK, INC., Collegedale, Tennessee, have been utilized.

#### 1.2 WORK INCLUDED

The Contractor shall:

- A. Furnish and install cabinets and casework including tops, ledges and supporting structures, and miscellaneous items of equipment as listed in the equipment schedules or as shown on the drawings, including delivery to the buildings, unpacking, setting in place, leveling and scribing walls and floors as required. Furnish and install all filler panels, knee space panels where specified and scribes required for a finished installation.
- B. Furnish and install all utility service outlet accessory fittings, electrical receptacles and switches when required, or as shown on drawings as mounted on or in conjunction with the casework.
- C. Furnish and install all sinks, cup sinks or drains, drain troughs, overflows and sink outlets, where specified, which occur above the floor and where these are part of the equipment as listed in equipment schedules or shown on the drawings. Integral tail pieces shall be in accordance with the manufacturer's standards.

#### 1.3 QUALIFICATIONS

Evidence of qualifications shall be furnished by the prospective supplier as follows:

- A. Adequate physical facilities and personnel for manufacturing a project of this size.

- B. Financial ability to execute contractual obligations.
- C. Qualified engineering department to provide layout, roughing in and shop drawings for approval prior to fabrication of equipment.
- D. Completion of five (5) comparable installations during the past five (5) years.

#### 1.4 SAMPLES

Upon request, the prospective supplier shall furnish:

- A. Base unit containing both drawer and cupboard. Should a top be provided, it shall be removable without tools to allow convenient observation of internal construction.
- B. Table corner sample showing frame construction and table leg.
- C. Samples of representative utility service fixture, lock, hinge and pull.
- D. Samples of all top materials required on project.

#### 1.5 SHOP DRAWINGS

Shop drawings shall show layout and dimensions for reference by mechanical trades, product reference numbers, construction details where necessary and relationship of this work to other work.

#### 1.6 FIELD MEASUREMENTS

Field measurements shall be taken to verify that the equipment will fit into the designated space. Entry ways, corridors and door openings shall be verified to ensure that the equipment be manufactured in a manner to permit it to be moved through properly into place.

#### 1.7 WARRANTY

Casework manufacturer shall guarantee to replace or repair, at no expense to the owner, all materials of this contract found to be defective within one (1) year of acceptance, due to defective materials and/or workmanship.

### PART 2. PRODUCTS

#### 2.1 MATERIALS

- A. Solid woods shall be properly air-dried, kilned to five (5) -six (6) percent moisture content and then tempered in inside storage to a moisture content of six (6) - seven (7) percent. Woods showing on exposed



surfaces shall be hard Maple or plain sliced Red Oak, carefully selected for color and grain. Woods used in interior construction may be maple, birch or other suitable hardwoods, clear and sound.

- B. Lumber core shall be balanced construction consisting of a solid hardwood stave core, hardwood cross plies and face veneers of selected Maple or plain sliced Red Oak. Lumber core for doors shall additionally include an internal end band. Lumber core shall conform to HPVA HP-1 1993 product standards.
- C. Plywoods shall be balanced veneer core construction glued with water resistant resin adhesives. Hardwood plywoods for exposed surfaces may have face veneers of selected Maple or plain sliced Red Oak and shall conform to HPVA HP-1 1993 product standards. Plywood for interior and unexposed surfaces may be hardwood plywoods or softwood plywoods conforming to U.S. Department of Commerce and Voluntary Product Standard PS-1 (interiors of open cases and cases with glass or glazed doors are considered exposed surfaces).
- D. Particle boards shall be nominal 45 pound density industrial boards, mat- formed as flat panels, bonded together with synthetic resin under heat and pressure, conforming to commercial standard CSA-236.
- E. Tempered Welded Fiber shall be exploded wood fibers and natural lignin binding agent compressed into dense homogeneous sheets. Sheets are impregnated with a special tempering compound polymerized by baking to give exceptional strength.
- F. Glass for framed glazed doors shall be double strength. Glass for frameless sliding doors shall be one-fourth (1/4) inch plate. Glass for fume hood sashes shall be one-fourth (1/4) inch laminated safety glass.
- G. Plastic laminate shall be phenolic resin, high pressure, decorative laminates conforming to ANSI/NEMA LD3-1991 standard for intended uses. Countertop applications shall use regular general purpose or post-forming types.

## 2.2 CONSTRUCTION

- A. Base units shall be designed with solid ends and backs, semi-overlap radius lipped doors and drawers, astragal strip between double swinging doors and fully enclosed toe space protecting all interior against dust and vermin. End panels shall be three-quarter (3/4) inch plywood with front exposed edges of panels faced with solid hardwood. End panels shall be glued to horizontal frame units and to solid bottom panels. Joint construction shall be blind, not extended to face of cases. Joinery utilizing blind mortise and ten on, multiple dowel or stopped tongue and groove shall be acceptable. Backs shall be one-fourth (1/4) inch tempered welded fiber, grooved into end panels. Where access to services is required, cupboard backs shall be removable Cupboard bottoms shall be

three-quarter (3/4) inch plywood with exposed edge faced with solid hardwood providing a flush interior for ease of cleaning. Lock security panels shall be one-fourth (1/4) inch tempered welded fiber fitting into an integral groove within the intermediate frame units. Shelves shall be half-depth, adjustable and made of three-fourths (3/4) inch plywood with exposed edge faced with solid hardwood. All toe space shall be two and one-half (2-1/2) inches deep and four (4) and one-fourth (1/4) inch high, fully enclosed and an integral part of the case. Horizontal frame member sizes are as follows:

Top Horizontal:

Front & Rear	2-1/2" x 1-1/4" hardwood
Side	1-1/4" x 1-1/4" hardwood
Center	1-1/4" x 1-1/4" hardwood

Intermediate Horizontal:

Front & Rear	2-1/2" x 3/4" hardwood
Side	1-1/4" x 3/4" hardwood
Center	3-1/4" x 3/4" hardwood

Bottom:

Bottom to be 3/4" plywood with exposed edge faced-with solid hardwood providing flush interior.

- B. Wall cases shall be integrally constructed to provide a fully enclosed unit designed to ensure a dust and vermin free interior. End panels shall be three-fourths (3/4) inch plywood with exposed edges faced with solid hardwood. Tops and bottoms shall be one (1) inch plywood with exposed front edges faced with hardwood. End panels shall be glued to top and bottom panels through blind mortise and tenon or doweled joints. Further reinforcement through screws, cleats, hot glue and stapled pins shall be provided as required. Backs shall be one-fourth (1/4) inch hardwood plywood (exposed) or tempered welded fibre (behind solid door), grooved into end and bottom panels and further secured through the use of glue and unexposed top and bottom back rails. The interior of the case shall be completely flush for ease of cleaning. Shelves shall be one (1) inch plywood with front edge faced with solid hardwood, fully adjustable.
- C. Tall cases shall be integrally constructed to provide a fully enclosed unit designed to ensure a dust and vermin free interior. End and bottom panels shall be three-fourth (3/4) inch plywood with exposed edges faced with solid hardwood. Top panel shall be one (1) inch plywood with exposed front edge faced with solid hardwood. End panels shall be glued to top and bottom through blind mortise and tenon or doweled joints. Further reinforcement through screws, cleats, hot glue and stapled pins shall be provided as required. Fixed shelves shall be firmly mounted on supporting cleats or appropriate internal joinery. Backs shall be one-fourth (1/4) inch hardwood plywood where exposed, one-fourth (1/4) inch tempered welded fiber behind solid doors, grooved into end panels and

further secured with glue, staples and unexposed top and bottom back rails. The interior of the case shall be completely flush for ease of cleaning. All shelves shall be minimum three-fourth ( $\frac{3}{4}$ ) inch plywood. Shelves shall have the front edge faced with solid hardwood. Adjustable shelves shall be fully adjustable with shelves over 47 inches in length to have additional support at center of shelf. All toe spaces shall be two and one-half ( $2\frac{1}{2}$ ) inches deep and four (4) and one-fourth ( $\frac{1}{4}$ ) inch high, matching base units, fully enclosed and an integral part of the case.

- D Panel Doors shall be solid core construction consisting of a hardwood banded core, one-sixteenth ( $\frac{1}{16}$ ) inch poplar cross-ply poplar cross-plys and select hardwood veneer faces. Doors shall be three-fourths ( $\frac{3}{4}$ ) inch thick except hinged doors over 48 inches in height which shall be one (1) inch thick. All doors shall be radiused lip on edges of swinging doors, straight on sliding doors. Double swinging doors shall meet with an astragal being formed by way of the right hand door overlapping an inset lip on the left hand door. Hinged doors shall have two (2) hinges per door for doors to 42 inches high and three (3) hinges per door over 42 inches high. Sliding doors shall be hung on adjustable hangers and ride on nylon rollers on an extruded aluminum track attached to the upper front rail or panel of the case.
- E Glazed doors shall have framing members of solid hardwood one (1) by three (3) inches. Horizontal and vertical members shall be joined through mortise and tenon or doweled joints, glued and pinned. Glass shall set into doors from rear and shall be held in place by resilient plastic molding. Door operation, hinged or sliding, shall be identical to doors above.
- F Drawers shall have fronts three-fourths ( $\frac{3}{4}$ ) inch thick of solid five (5) ply hardwood lumber core construction laminated with select hardwood veneer faces with radius lip to match doors. Drawer box members shall be one-half ( $\frac{1}{2}$ ) inch laminated hardwood with sides dovetailed to front of drawer and back dovetailed or dadoed into sides. All joints shall be glued. Bottom of drawers shall be one-fourth ( $\frac{1}{4}$ ) inch tempered welded fiber, grooved into front, sides and back of drawer. Drawer bottoms shall be further secured with hot glue flowed into the bottom retention groove from the underside thus forming a rigid and unitized drawer box. Drawer guide system shall be three (3) point suspension system. A self-lubricating nylon back plate shall be integrally assembled at the back of the drawer and shall glide over a "T" shaped wood guide secured to the cabinet rails with screws. Two (2) nylon angle clips shall be secured to the rails as a sliding surface for the drawer sides. Drawers longer than 28 inches shall have dual "T" guides. Drawer guide system shall provide smooth operation under all load conditions.
- G Table legs shall be two and one-fourth ( $2\frac{1}{4}$ ) inches square with all comers radiused three-sixteenths ( $\frac{3}{16}$ ) inch. Legs shall be secured to apron frame by a three-eighths ( $\frac{3}{8}$ ) inch heavy-duty hanger bolt

through a 13 gauge metal corner brace. Brace shall be dadoed into apron rails and securely fastened with screws. Exterior apron rails shall be one (1) inch lumber core with bottom edge radiused. Compartment bottoms shall be one-fourth (1/4) inch hardboard glued and pinned in place. Leg stretchers shall be provided where required, one and one-fourth (1-1/4) by two and one-half (2-1/2) inches, secured to legs with a draw bolt at each end. A two and one-half (2-1/2) inch high die formed boot shall be fitted to each fixed leg at the floor concealing the leveling/anchoring device. Movable tables shall have legs fitted with one and one-half (1-1/2) inch diameter adjustable non-marring floor glides.

- H. Wall hung shelves shall be open construction without backs. Uprights shall be three-fourths (3/4) inch thick. Shelves shall be three-fourths (3/4) inch thick for spans to three (3) feet and one (1) inch for spans over three (3) feet. Material shall be solid maple or five (5) ply hardwood lumber core with hard maple faces. Top, bottom and intermediate shelves shall be attached securely with glue and screws. Finish shall be chemical resistant black or natural stain.
- I. Regent rack shelves shall be minimum 13/16 inch thick with black chemical resistant surface. Long edges shall have corrosion and impact resistant retainer lip edging. Upright supports shall be one (1) inch thick and have a black melamine surface. Uprights having a wood composite core shall have a two (2) inch wide foot (Permaresin) attached securely with adhesive sealant and screws. Closed racks shall have three-fourths (3/4) inch thick by eight (8) inch high facia attached to the upright supports concealing the mechanical piping, with provision for mounting service fixtures on the facia. Upright supports shall be bored to accommodate specified piping and conduit as required.

## 2.3 HARDWARE

- A. Pulls for drawers and doors shall be of clean, modern design offering a comfortable hand grip and shall attach to drawer or door with machine screws on four (4) inch centers. Pulls shall be of extruded aluminum with satin lacquer finish.
- B. Flush pulls for bypass sliding doors shall be satin chrome finish, recessed to provide finger grip.
- C. Latching assembly for tall case double swinging doors shall consist of an eccentric plate operating two and one-eighth (2-1/8) inch by five-eighths (5/8) inch plated vertically operating locking bars. Each bar shall operate through an extruded nylon guide and, when locked, shall engage a strike plate providing positive latching for the left hand door.

The lock attached to the right hand door shall operate a bolt which, when locked, shall overlap the left hand door providing secure locking. Single doors shall be locked to case sides.

- D. Hinges shall be five (5) knuckle institutional type heavy duty hinges with offset wrap around wings. Hinges shall be two and one-half (2-1/2) inch stainless steel, satin finish. Hinges are to be mounted to door and case with not less than three (3) screws per wing.
- E. Sliding doors shall be suspended with adjustable hangers on nylon rollers and ride with minimum margin between doors on extruded aluminum track. Bottoms of doors shall operate through a nylon guide. :
- F. Plate glass shall be one-fourth (1/4) inch plate glass. The bottom edge of the door shall be fitted with an aluminum extrusion into which concealed rollers are mounted. Side and upper tracks shall conceal and secure edges of doors when closed. Bottom extrusion shall be a track to guide concealed rollers. Edges of doors shall be seamed and a finger pull shall be securely adhered to the glass.
- G. Catches shall be provided on swinging doors and shall be a spring-loaded nylon roller type.
- H. Elbow catches shall be used on left hand doors where required for latching security when doors are to be locked. Elbow catches shall be steel, zinc plated.
- I. Locks shall furnished only where specified, shown on drawings or where included as part of a cataloged item. Locks for all areas including plate glass sliding doors shall be laboratory grade with two (2) sets of four (4) tumblers operating in opposite sides. Lock action shall be cam type without use of spring action, master keyed and furnished with two (2) keys per lock. Locks for sliding plate glass doors shall be ratchet type, master keyed with other locks.
- J. Number plates shall be non-corrosive black with highly contrasting light numbers and attached adjacent to the lock and in the key case with suitable adhesive. Number plates shall be furnished only where specifically noted on drawings or called for in equipment schedules.

- K. Drawer stops shall be provided on all drawers to prevent inadvertent removal. Stops shall be automatic type, zinc plated steel.
- L. Shelf supports shall be die-formed to insert into pre-drilled holes on interior of cabinets. Supports shall provide shelf adjustment on 32 mm centers shelves longer than four (4) inches shall have additional support at center. Shelf supports shall be plated steel.
- M. Base molding shall be pliable, black four (4) inch high coved to the floor at the bottom and shall be cemented tightly to exposed case areas at the floor with suitable adhesive.
- N. Stainless steel comers shall be furnished on all exposed base comers and shall be designed to conform to the contour of the base molding and be attached with four (4) stainless steel nails. Finish shall be brushed.
- O. Leg shoes shall be die formed, black in color and finished on all fixed open table legs, two and one-half (2-1/2) inches high and coved to floor and shall conceal leg leveling/anchoring clips and screws.
- P. Floor guides specified for movable open leg tables shall be a non-marring material at least one and one-half (1-1/2) inch diameter to prevent in denting composition flooring and shall allow at least a five-eighths (5/8) inch adjustment.

## 2.4 SINKS AND TROUGHS

- A. Permaresin sinks and drain troughs shall be made of modified epoxy resins and shall be completely cured during processing. Sinks shall have a high resistance to physical and thermal shock.

## 2.5 MECHANICAL SERVICE FIXTURES AND ACCESSORIES

Laboratory fixtures shall be of red metal, laboratory grade with a copper content of at least 85% (except forged units) and shall have a heavy duty polished chrome finish. Serrated hose connectors shall be provided on all fixtures, either removable or an integral part, unless otherwise specified. Vacuum breakers shall be of chrome plated brass and will not be furnished unless specifically called for in equipment schedules or on drawings.

- A. Water fixtures shall be of the replaceable cartridge type and shall be convertible to or from self closing without disturbing the faucet installation. Fixture outlets shall be tapped three-eighths (3/8) inches straight thread IPS to accommodate removable hose connections, filter pumps, aerators, etc.
- B. Index of buttons mounted in fixture handles shall identify the following

services. Buttons shall be color coded and lettered.

Hot Water	HW	Red
Cold Water	CW	Green
Gas	GAS	Blue
Air	AIR	Orange
Vacuum	VAC	Yellow
Distilled Water DW	White	

- C Sink outlets for resin sinks shall be chemical resistant resin with removable disk strainer, locknut and machining for overflow. Assembly shall be threaded standard one and one-half (1-1/2) inches for connection to waste system. Overflow will not be furnished for sink outlet except as specifically\_ called for in equipment schedules or in drawing.
- D Sink outlets for stainless steel sinks shall be crumb cup stainers, chrome plated brass or stainless steel.

## 2.6 COUNTERTOPS

Countertops, unless otherwise specified, shall be nominal one (1) inch thick. All tops shall be supplied in the largest practicable sizes and field joined using waterproof and chemical resistant epoxy base cements.

- A. Permaresin tops shall be molded from modified epoxyresms and inert fillers that have been compounded and completely cured in processing to give optimum physical and chemical resistance properties required of a heavy duty laboratory table top. Tops and curbs shall be a homogenous mixture throughout the full thickness and shall not depend upon a surface coating that may be removed by chemical and/or physical abuse. Tops and curbs shall be a non-glaring, medium sheen black. Provide raised lip along front and end of edge.

## 2.7 CASEWORK FINISH

All exteriors and exposed surfaces to receive finish shall be free of machine marks, carefully and smoothly sanded in preparation for finishing. Exteriors, inside surfaces of doors, cupboard interiors and shelves shall then be stained, followed by resinous sealer, dried properly and carefully sanded. Two (2) coats of chemical resistant catalyzed synthetic alkyd-urea resin varnish shall then be applied and thoroughly dried, resulting in a smooth semi gloss finish. Drawer boxes shall receive the same finish except that the stain may be omitted. Bottoms, unexposed backs and ends shall be sealed with pigmented resinous sealer. Top frames, interior of drawer openings and toe eases shall be sealed with clear sealer.

## PART 3. EXECUTION

### 3.1 COORDINATION

The casework supplier shall cooperate with the General Contractor and with associated trades to coordinate the delivery and installation of this equipment.

A. General conditions indicating readiness for delivery include:

1. Overhead ceiling work - ductwork, lighting, acoustical ceiling, etc. - is complete.
2. Windows and exterior doors are installed. Building is secure and weathertight.
3. Air circulation control system is functioning and maintaining relatively constant temperature and humidity conditions closely approximate to those to be maintained by the Owner.

B. In that equipment furnished in this section is factory pre-finished, it is recommended that all painting be completed in the areas in which casework is to be installed prior to such installation. Casework may be installed over finished flooring.

### 3.2 INSTALLATION

A The casework specified herein shall be delivered to the building in pre-finished modular units. It shall be set in place, leveled, secured to walls or floors as necessary, trimmed or scribed to make a neat installation. Installation shall be under the direction of a factory approved superintendent.

B The contractor shall deliver all sinks, troughs, service fixtures, etc., as supplied in this section for installation and connection by the appropriate trades. See 1.2 B, C.

C. Remove all debris, dirt, rubbish and excess material accumulated as a result of the installation of this equipment to designated job site disposal area and leave casework clean and orderly.

### 3.3 PROTECTION

General Contractor shall be responsible for site security and protection of this equipment. Damage to equipment resulting from the work or acts of other trades or contractors shall be responsibility of the Owner.

END OF SECTION



## **SECTION 11601**

### **STEEL LABORATORY CASEWORK**

#### **PART 1 GENERAL**

##### **1.1 SUMMARY AND SCOPE**

- A. Furnish all cabinets and casework, including tops, ledges, supporting structure Include delivery to the building, set in place, level, and scribe to walls and floors as required. Furnish and install all filler panels, knee space panels and scribes as shown on drawings.
- B. Furnish and deliver all utility service outlet accessory fittings, electrical receptacles and switches identified on drawings as mounted on the laboratory furniture. All plumbing and electrical fittings, not preinstalled in equipment, will be packaged separately and properly marked for delivery to the appropriate contractor.
- C. Furnish and deliver, for installation by the mechanical contractor, all laboratory sinks, cup sinks or drains, drain troughs, overflows and sink outlets with integral tailpieces, -which occur above the floor, and where these items are part of the equipment All tailpieces shall be furnished less the couplings required to connect them to the drain piping system.
- D. Furnish service strip supports where specified, and setting in place service tunnels service turrets, supporting structures and reagent racks of the type shown on the drawings.
- E. Removal of all debris, dirt and rubbish accumulated as a result of the installation of the laboratory furniture to an onsite container provided by others, leaving the premises broom clean and orderly.

##### **1.2 RELATED WORK**

- A Section 09260: Gypsum Board Systems.
- B. Section 09650: Resilient Flooring.
- C. Division 15 and 16: Plumbing and electrical.

##### **1.3 RELATED PUBLICATIONS**

- A SEFA 3 -Scientific Equipment and Furniture Association.
- B. SEFA 8 -Scientific Equipment and Furniture Association

- C NFPA **30** - National Fire Protection Association.
- D NFPA-45 - National Fire Protection Association.
- E UL - Underwriters Laboratories.
- F ASTM D522 - Bending Test.

#### 1.4 BASIS OF WORK

- A. Supply all equipment in accordance with tins specification. The offering of a product differing in materials and construction from tins specification requires written approval from the owner/architect. This approval must be obtained seven (7) days before the quotation deadline. Procedures for obtaining approval for an alternate manufacturer are defined in this specification.
- B. Participants in tire quotation process have the option of clarifying deviations to the specified design, construction, or materials. Without such clarifications, sealed quotations to the owner or owner representative will be construed as being in total conformance to the requirements of the specification.
- C. The owner / owner representative reserves the right to reject qualified or alternate proposals and to award based on product value where such action assures the owner greater integrity of product.

#### 1.5 QUALITY ASSURANCE

- A. The steel laboratory furniture contractor shall also provide worktops manufactured or shipped from the same geographic location to assure proper staging, shipment and single source responsibility.
- B. General Performance: Provide certification that furniture shall meet the performance requirements described in SEFA 8.

#### 1.6 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's data and installation instructions for each type of casework. Provide data indicating compliance with SEFA 8.
- B. Samples: If requested, samples from non-specified manufacturer will be required and reviewed per specification. Samples shall be delivered, at no cost to the architect or owner to a destination set forth by the architect or owner. Samples shall be full size, production type samples. Miniature or "Show Room" type samples are not acceptable. Furnish die following:

1. One 18" combination (1) drawer and (1) base unit showing complete construction details, including (1) shelf.
2. One 36" acid storage base cabinet typical of specified elevations.
3. One sample of all top materials shown or called for, of sufficient size to perform finish requirement tests.
4. Sample of all mechanical service fittings, locks, door pulls, hinges, and interior hardware.

#### C. SHOP DRAWINGS

1. Submit shop drawings for furniture assemblies showing plans, elevations, ends, cross-sections, service run spaces, location and type of service fittings.
2. Coordinate shop drawings with other work involved.
3. Provide roughing-in drawings for mechanical and electrical services when required.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Steel casework shall be manufactured by Kewaunee Scientific Corporation, Research Collection, Scott Laboratory Solutions, Hamilton Scientific, LLC, or approved equal. All laboratory equipment covered by the specification shall be the product of one manufacturer and be fabricated at one geographic location to assure shipping continuity and single-source responsibility. All quotations from a manufacturer other than Kewsunee Scientific Corporation shall contain a review of the following capabilities:
  1. List of shop facilities
  2. List of engineering and manufacturing personnel
  3. Proof of financial ability to fulfill the contract
  4. List of a minimum of ten (10) installations over the last five (5) years of comparable scope
  5. Proof of project management and installation capabilities
  6. SEFA member in Good Standing
- B. The selected manufacturer must warrant for a period of one-year starting (date of acceptance or occupancy, whichever comes first) that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.
- C. The architect will retain the above samples of the successful manufacturer or owner to insure that material delivered to jobsite conforms in every respect to the samples submitted.

## 2.2 CABINET STYLE

- A. Steel Cabinet bodies, drawer bodies, shelves, drawer heads and door assemblies shall be fabricated from Cold Rolled Steel.

## 2.3 DRAWER AND DOOR STYLE

- A. Trademark Inset - Style 01 - The outer drawer and door head shall have a channel formation on all four sides to eliminate sharp raw edges of steel and the top front comers shall be welded and ground smooth. Drawer and door, when closed, shall be recessed to create an overall flush face.

## 2.4 MATERIALS

- A. It is the intent of this specification to provide a high quality steel cabinet specifically designed for the laboratory environment

### B. STEEL

#### 1. Cold Rolled Steel:

Cold rolled sheet steel shall be prime grade 12,14,16,18 and 20 gauge U.S. Standard; roller leveled, and shall be treated at the mill to be free of scale, ragged edges, deep scratches or other injurious effects.

### C. HARDWARE AND TRIM

1. Drawer and Door Pulls: Rounded Aluminum -1 - Pull shall be of modern design, offering a comfortable handgrip, and be securely fastened to doors and drawers with screws. All pulls shall be satin finish aluminum, with a clear, lacquer finish. Two pulls shall be required on all drawers over 24" long. Use of plastic pulls (molded or extruded), or a design not compatible for usage by the handicapped will not be acceptable.
2. Hinges: Hinges shall be made of Type 304 stainless steel .089 thick, 2-1/2" high, with brushed satin finish, and shall be the institutional type with a five-knuckle bullet-type barrel. Hinges shall be attached to both door and case with two screws through each leaf. Welding of hinges to door or case will not be accepted. Doors under 36" in height shall be hung on one pair of hinges, and doors over 36" high shall be hung on 3 hinges.
3. Locks, Disk Tumbler Locks when shown or called for shall be a 5-disc tumbler with heavy duty interchangeable cylinder. Exposed lock noses shall be dull nickel (satin) plated and stamped with identifying numbers. Locks shall have capacity for 2000 primary key changes. Master key one level with the potential of 10 different, non-interchangeable master key groups.

4. Positive Catch: A two-piece heavy-duty cam action positive catch shall be provided on all base cupboard doors and shall be positioned near the pivoting edge of door to provide a clean unobstructed opening. Main body of the catch shall be confined within an integral cabinet divider rail, while latching post shall be mounted on the hinge side of door. Nylon roller type catches are not acceptable.
5. Elbow Catches: Elbow catches and strike plates shall be used on left bund doors of double door cases where locks are used, and are to be burnished cast aluminum with bright brass finish.
6. Shelf Adjustment Clips: Shelf adjustment clips shall be nickel-plated steel.
7. Base Molding: Base molding shall be provided by others.
8. Support Rods, Upright Rod Assemblies and Rod Sockets: Upright rods, cross rods and ring support rods, where specified, shall be anodized Duralumin (2" or 3/4" dia., as required). Rod sockets shall be chrome-plated brass, secured through tabletops with lock nut and spring washer. Rod clamps shall be heavy duty, designed to securely hold rod assembly in any position. Use of wood rod assemblies will not be accepted.

## 2.5 CONSTRUCTION

### A. STEEL BASE CABINET CONSTRUCTION

#### 1. General

- a. The steel furniture shall be of modern design and shall be constructed in accordance with the best practices of the Scientific Laboratory Equipment Industry. First class quality casework shall be insured by the use of proper machinery, tools, dies, fixtures and skilled workmanship to meet the intended quality and quantity for the project
- b. All cabinet bodies shall be Audi front construction with intersection of vertical and horizontal case members, such as end panels, top rails, bottoms and vertical posts in same plane without overlap. Exterior comers shall be spot welded with heavy back up reinforcement at exterior comers. All free joints shall be welded and ground smooth to provide a continuous flat plane. ;
- c. Each cabinet shall be complete so that units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.
- d. Case openings shall be rabbetted on all four sides for both hinged and sliding doors to provide a dust resistant case.
- e. All cabinets shall have a cleanable smooth interior. Bottom edges shall be formed down on sides and back to create easily cleanable comers with no burrs or sharp edges, and front edge shall be offset to create a seamless drawer and door recess rabbit for dust stop.

2. Steel Gauges: Gauges of steel used in construction of cases shall be 18 gauge except as follows:

- a. Comer gussets for leveling bolts and apron comer braces, 12 gauge.
- b. Hinge reinforcements, case and draw«: suspension channels, 14 gauge.
- c. Top and intermediate front horizontal rails, table aprons and reinforcement gussets, 16 gauge.
- d. Drawer assemblies, door assemblies and adjustable shelves, 20 gauge.

3. Base Cabinets: End uprights shall be formed into not less than a channel formation at top, bottom, bade and front. The front edge shall further offset to form a strike for doors and drawers, and shall be perforated for the support of drawer channels, intermediate rails and hinge screws. An upright filler shall be screwed in place in all cupboard units to close the back of the channel at front of the upright and to provide a smooth interior for the cupboard to facilitate cleaning. The upright filler shall be perforated with shelf adjustment holes at not more than 2" centers painted prior to assembly. The inside front of die upright shall be further reinforced with a full height 14 gauge hinge reinforcement angle.

- 4. Top horizontal rail on base cabinets shall interlock within the flange at top of end panels for strength, but shall be flush as face of unit Top rail shall have a full width rabbet for swinging doors and drawers. Reinforcements shall be provided at all front comers for additional welded strength between vertical and horizontal case members.

- a. Intermediate rails shall be provided between doors and drawers, but shall not be provided between drawers unless made necessary by locks in drawers. When required, intermediate rails shall be recessed behind doors and drawer fronts, and designed so that security panels may be added as required.
- b. Intermediate vertical uprights shall be furnished to enclose cupboards when used in a unit in combination with a half width bank of drawers. However, to allow storage of large or bulky objects, no upright of any type shall be used at the center of double door cupboard units.
- c. Cabinet bottom, and bottom rail shall be formed of one piece of steel except in comer units and shall be formed down on sides and back to create a square edge transition welded to cabinet end panels, and front edge shall be offset to create a seamless drawer and door recess rabbet for dust stop.
- d. Toe space rail shall extend up and forward to engage bottom rail to form a smooth surfaced fully enclosed toe space, 3" deep x 5" high. Whenever toe space base is omitted for units to set on building bases on separate steel bases, then the toe space rail shall extend back 4-1/2".
- e. Back construction shall consist of a top and bottom rail, channel formed for maximum strength and welded to back and top flange of end uprights, open for access to plumbing lines. Cupboard units only shall be provided with removable back panels.
- f. Die formed gussets, with multiple ends for strength, shall be furnished in each bottom comer of base units to insure rigidity, and a 3/8"-16 leveling bolt, 3" long, shall engage a clinch nut in each gusset. Access to the leveling bolts shall be through plug buttons in the bottom pan. Each leveling bolt and gusset shall be capable of supporting 500 lbs. Access to leveling bolts through toe space or leveling bolts requiring special tools to adjust are not acceptable.

- g. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear; formed down 3/4" at each end, shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf
- h. Drawer bodies shall be made in one-piece construction including the bottom, two sides, back and front. They shall be fully coved at interior bottom on all four sides for easy cleaning. The top front of the inner drawer body shall be offset to interlock with the channel formation in drawer head providing a 3/4" thick drawer head.
- i.. Drawer suspension assembly shall consist of 2 sections providing a quiet, smooth operation on ball bearing nylon rollers. All drawers shall be self-closing from a point S" open. Cabinet channels shall maintain alignment of drawer and provide an integral drawer stop, but the drawer shall be removable without the use of tools. Drawers shall provide 13-5/8" front to back clearance when fully extended. Drawers shall rise when opened thus avoiding friction with lower drawers and/or doors. Drawer suspension system shall incorporate a double stop, lock open feature. Case suspension channels shall be Galvanized Steel, drawer suspension channels shall be Cold Rolled Steel. Drawer suspension channels on Stainless Steel Cabinets shall be zinc plated after they are formed.
- j. Steel Door assembly (two-piece) for solid pan swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed at all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contain sound deadening material.
- k. Steel Drawer/door assemblies shall be painted prior to assembly. Both shall be punched for attaching drawer pulls. Likewise, inner pan formation of door and drawer body shall be indented for in-field installation of locks when required.
- l. Doors shall be readily removable and hinges easily replaceable. Hinges shall be applied to the cabinet and door with screws. Welding of hinges to either cabinet or door will not be acceptable.
- m. Knee space panels, where shown or specified, shall be 18 gauge, finished same as casework cabinets, and easily removable for access to mechanical service areas.

## B STEEL SWINGING DOOR UPPER CABINET CONSTRUCTIONS

1. Swinging door storage cabinets shall have a completely finished interior same as exterior.
2. End uprights shall be formed at the front in a 1" channel formation with the inside flange formed to provide a 31132" x 1/2" door recess. The back of the upright shall be formed to a 2-1/2" formation. A 14 gauge hinge reinforcement same as specified for BASE CABINETS, shall be welded to inner side of front uprights.

Cabinet tops shall be formed into a 1" x 1-3/16" channel shape at front, with a 31/32" x 1/2" offset for door recess, and with flange at rear and sides for electro-welding cabinet top to cabinet back and ends.

3. Cabinet flush bottoms shall be formed with a " wide front fascia and a 13/16" channel shape formation at front edge flanged back and up to create a door recess rabbet for dust stop.
4. Cabinet backs shall be welded to the top, bottom and ends. Backs shall be perforated for shelf adjustment holes on not more than 1" centers. Holes shall be set in a channel formation in cabinet back and enclosed by end uprights.
5. Adjustable shelves shall be formed down 3/4", returned back 7/8" and up 1/4" into a channel formation front and rear, formed down 3/4" at each end, shelves over 42" long shall be further reinforced with a channel formation welded to underside of shelf.
6. Door assembly (two-piece) for solid panel swinging doors shall consist of an inner and outer door pan. Outer door pan shall be formed into a channel or flanged shape on all four sides. The corners on the pull side of the outer door pan shall be welded and ground smooth to prevent exposure of sharp edges of steel at these critical points. Inner door pan shall be flanged at all four sides with hinge reinforcements welded in place. The door assembly shall be 3/4" thick and contains sound deadening material.

## 2.6 PERFORMANCE REQUIREMENTS

### A. Steel Casework Construction Performance:

1. Base cabinets shall be constructed to support at least a uniformly distributed load of 200 lbs. per square foot of cabinet top area, including working surface without objectionable distortion or interference with door and drawer operation.
2. Base cabinet corner gussets with leveling bolts shall support 500 lbs. per corner, at 1-1/2" projection of the leveling bolt below the gusset.
3. Each adjustable and fixed shelf 4 ft. or shorter in length shall support an evenly distributed load of 40 lbs. per square ft. up to a maximum of 200 lbs., with nominal temporary deflection, but without permanent set.
4. Drawer construction and performance shall allow 13-5/8" clear when in an extended position and suspension system shall prevent friction contact with any other drawer or door during opening or closing. All drawers shall operate smoothly a minimum of 10,000 cycles with an evenly distributed load of 150 lbs.
5. Swinging doors on floor-mounted casework shall support 200 lbs. suspended at a point 12" from hinged side, with door swung through an arc of 160 degrees. Weight load test shall allow only a temporary deflection, without permanent distortion or twist. Door shall operate freely after test and assume a flat plane in a closed position.



## B Steel Paint System Finish and Performance Specification:

### 1. Steel Paint System Finish:

- a. After Cold Rolled Steel and Textured Steel component parts have been completely welded together and before finishing, they shall be given a pre-paint treatment to provide excellent adhesion of the finish system to die steel and to aid in the prevention of corrosion. Physical and chemical cleaning of die steel shall be accomplished by washing with an alkaline cleaner, followed by a spray treatment with a complex metallic phosphate solution to provide a uniform fine, grained ciystal line phosphate surface that shall provide both an excellent bond for the finish and enhance the protection provided by the finish against humidity and corrosive chemicals.
- b. After die phosphate treatment, die steel shall be dried and all steel surfaces «hull be coated with a chemical and corrosion-resistant, environmentally friendly, electrostatically applied powder coat finish. All components shall be individually painted, insuring that no area be vulnerable to corrosion due to lack of paint coverage. The coating shall then be cured by baking at elevated temperatures to provide maximum properties of corrosion and wear resistance
- c. The completed finish system in standard colors shall meet the performance test requirements specified under PERFORMANCE TEST RESULTS:

### 2. Performance Test Results (Chemical Spot Tests):

#### a. Testing Procedure:

Chemical spot tests for non-volatile chemicals shall be made by applying 5 drops of each reagent to the surface to be tested and covering with a 1-1/4" dia. watch glass, convex side down to confine the reagent Spot tests of volatile chemicals shall be tested by placing a cotton ball saturated with reagent on the surface to be tested and covering with an inverted 2-ounce wide mouth bottle to retard evaporation. All spot tests shall be conducted in such a manner that the test surface is kept wet throughout the entire test period, and at a temperature of 77° ±3° F. For both methods, leave the reagents on the panel for a period of one hour. At the end of die test period, the reagents shall be flushed from the surface with water, and die surface scrubbed with a soft bristle brush under running water, rinsed and dried. Volatile solvent test areas shall be cleaned with a cotton swab soaked in the solvent used on the test area. Immediately prior to evaluation, 16 to 24 hours after die reagents are removed, die test surface shall be scrubbed with a damp paper towel and dried with paper towels.

#### b. Test Evaluation:

Evaluation shall be based on die following rating system. :

Level 0 — No detectable change.

Level 1 - Slight change in color or gloss.

Level 2 - Slight surface etching or severe staining.

Level 3 - Pitting, cratering, swelling, or erosion of coating. Obvious and significant deterioration.

After testing, panel shall show no more than three (3) Level 3 conditions,

c. Test Reagents

Test No	Chemical Reagent	Test Method
1.	Acetate, Amyl	Cotton ball & bottle
2.	Acetate, Ethyl	Cotton ball & bottle
3.	Acetic Acid, 98%	Watch glass
4.	Acetone	Cotton ball & bottle
5.	Add Dichromate, 5%	Watch glass
6.	Alcohol, Butyl	Cotton ball & bottle
7.	Alcohol, Ethyl	Cotton ball & bottle
8.	Alcohol, Methyl	Cotton ball & bottle
9.	Ammonium Hydroxide, 28%	Watch glass
10.	Benzene	Cotton ball & bottle
11.	Carbon Tetrachloride	Cotton ball & bottle
12.	Chloroform	Cotton ball & bottle
13.	Chromic Acid, 60%	Watch glass
14.	Cresol	Cotton ball & bottle
15.	Dichlor Acetic Add	Cotton ball & bottle
16.	Dimethylformanide	Cotton ball & bottle
17.	Dioxane	Cotton ball & bottle
18.	Ethyl Ether	Cotton ball & bottle
19.	Formaldehyde, 37%	Cotton ball & bottle
20.	Formic Add, 90%	Watch glass
21.	Furfural	Cotton ball & bottle
22.	Gasoline	Cotton ball & bottle
23.	Hydrochloric Acid, 37%	Watch glass
24.	Hydrofluoric Acid, 48%	Watch glass
25.	Hydrogen Peroxide, 3%	Watch glass
26.	Iodine, Tincture of	Watch glass
27.	Methyl Ethyl Ketone	Cotton ball & bottle
28.	Methylene Chloride	Cotton ball & bottle
29.	Mono Chlorobenzene	Cotton ball & bottle
30.	Naphthalene	Cotton ball & bottle
31.	Nitric Add, 20%	Watch glass
32.	Nitric Add, 30%	Watch glass
33.	Nitric Add, 70%	Watch glass
34.	Phenol, 90%	Cotton ball & bottle
35.	Phosphoric Add, 85%	Watch glass

36.	Silver Nitrate, Saturated	Watch glass
37.	Sodium Hydroxide, 10%	Watch glass
38.	Sodium Hydroxide, 20%	Watch glass
39.	Sodium Hydroxide, 40%	Watch glass
40.	Sodium Hydroxide, Flake	Watch glass
41.	Sodium Sulfide, Saturated	Watch glass
42.	Sulfuric Add, 33%	Watch glass
43.	Sulfuric Add, 77%	Watch glass
44.	Sulfuric Acid, 96%	Watch glass
45.	Sulfuric Add, 77% and Nitric Add, 70%, equal parts	Watch glass
46.	Toluene	Cotton ball & bottle
47.	Trichloroethylene	Cotton ball & bottle
48.	Xylene	Cotton ball & bottle
49.	Zinc Chloride, Saturated	Watch glass

3. Performance Test Results (Heat Resistance): Hot water (190° F - 205° F) shall be allowed to trickle (with a steady stream at a rate not less than 6 ounces per minute) on the finished surface, which shall be set at an angle of 45° from horizontal, for a period of five minutes. After cooling and wiping dry, the finish shall show no visible effect from die hot water treatment.
4. Performance Test Results (Impact Resistance): A one-pound ball (approximately 2" diameter) shall be dropped from a distance of 12 inches onto die finished surface of steel panel supported underneath by a solid surface. There shall be no evidence of cracks or checks in die finish due to impact upon close eye-ball examination
5. Performance Test Results (Bending Test): An 18 gauge steel strip, finished as specified, when bent 180° over a 1/2" diameter mandrel, shall show no peeling or flaking off of die finish.

## 2.7 WORK SURFACES

- A. Materials: 1" Epoxy Resin Tops and backsplash with nominal 36"x15"x1 1" double sink complete with all sink fittings, drains, eye wash.

## PART 3 EXECUTION

### 3.1 SITE EXAMINATION

- A. The Owner and/or his representative shall assure all building conditions conducive to die installation of a finished goods product; all critical dimensions and conditions previously checked have been adhered to by other contractors (general, mechanical, electrical, etc.) to assure a quality installation.

### 3.2 INSTALLATION

- A. Preparation: Prior to beginning installation of casework, check and verify that no irregularities exist that would affect quality of execution of work specified.
- B. Coordination: Coordinate the work of die Section with die schedule and other requirements of other work being prepared in die area at die same time both with regard to mechanical and electrical connections to and in die fume hoods and the general construction work.
- C. Performance:
  - 1. Casework:
    - a. Set casework components plumb, square, and straight with no distortion and securely anchor to building structure. Shim as required using concealed shims.
    - b. Bolt continuous cabinets together with joints flush, tight and uniform, and with alignment of adjacent units within 1/16" tolerance.
    - c. Secure wall cabinets to solid supporting material, not to plaster, lath or gypsum board.
    - d. Abut top edge surfaces in one true plane. Provide flush joints not to exceed 1/8".
  - 2. Work surfaces:
    - a. Where required due to field conditions, scribe to abutting surfaces.
    - b. Only factory prepared field joints, located per approved shop drawings, shall be permitted. Secure the joints in the field, where practical, in the same manner as in the factory.
    - c. Secure work surfaces to casework and equipment components with materials and procedures recommended by the manufacturer.
- D Adjust and Clean:
  - 1. Repair or remove and replace defective work, as directed by owner and/or his representative upon completion of installation.
  - 2. Adjust doors, drawers and other moving or operating parts to function smoothly.
  - 3. Clean shop finished casework; touch up as required.
  - 4. Clean work surfaces and leave them free of all grease and streaks.
  - 5. Casework to be left broom clean and orderly.

E Protection:

- 1 Provide reasonable protective measures to prevent casework and equipment from being exposed to other construction activity.
- 2 Advise owner and/or his representative of procedures and precautions for protection of material, installed laboratory casework and fixtures from damage by work of other trades.

END OF SECTION

## FILTRATION EQUIPMENT

## PART 1.0 GENERAL

## 1.1 SCOPE OF WORK

- A. All of the equipment described in this section shall be supplied by a single underdrain manufacturer regularly engaged in that business. This section requires the furnishing and installation of four (4) Leopold® Flat Bottom Flume® Filters as shown on the contract drawings. Each filter 12'-0" x 12'-0". The equipment to be supplied shall consist of:

1. Filter underdrain with I.M.S.-200 Media Retainer ®.
2. Filter media.
3. FRP wash water troughs.
4. Filter controls and field instrumentation
5. Filter Valves
6. Positive-displacement blower

B. References

1. NSF - Standard 61 - Drinking Water Systems Components - Health Effects.
2. AWWA B100 Water Treatment Filtering Material latest edition.
3. ANSI/AWWA F101 Contact-Molded, Fiberglass-Reinforced Plastic Washwater Troughs and Launderers.
4. ANSI/AWWA F102 Matched-Die-Molded, Fiberglass-Reinforced Plastic Weir Plates Scum Baffles and Mounting Brackets.
5. ASTM Standards listed in Section 1.4.H, Table 1.

## 1.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. General Requirements

1. The filter underdrain system shall be designed and installed to ensure long term stability in its operating characteristics. It shall be resistant to changes in head loss, flow uniformity, and any other effects which would in time cause loss of efficiency or effectiveness in its operation.
2. The underdrain system is intended to allow for the uniform collection of filtered water and uniform distribution of backwash water and air over the total area of the filter floor.
3. The backwash system shall allow for separate air scouring and water backwashing and for the simultaneous use of air and water at the specified rates.

4. The system shall be designed to avoid localized areas of excessive flow (maldistribution) which may cause mounding, lateral displacement, or other deleterious disturbances in the filter support gravel or media.
  5. When subjected to a flow rate of 20 gpm/sf (48.9 m/h) of filter area the headloss through an underdrain lateral 32 feet (9.75 m) long shall not exceed 45 inches (1140 mm) water column.
  6. To ensure the underdrain will control distribution (limit maldistribution) and not be over-powered by the media headloss, the minimum headloss through the orifices (primary and secondary) of an individual underdrain block shall not be less than 20 inches (510 mm) water column at a backwash flow rate of 20 gpm/sf (48.9 m/h) of filter area.
  7. The underdrain system shall have an integral grout pocket designed to provide uplift resistance as a result of internal pressurization of 30 PSI (2.068 Bar) without any external mechanical anchors. Underdrain blocks that do not have a grout pocket shall have external anchor rods embedded into the filter floor and shall extend above the underdrain and hold the underdrain down from the top. The external anchor system shall be designed for a minimum allowable load of 30 psi hold down across the filter. All anchors shall be tested prior to the placement of the underdrain block to 130% of the allowable load. All anchors shall be type 316 stainless steel.
  8. The filters shall consist of 12 inches of silica sand media, and 24 inches of anthracite media.
  9. An air scour system at the rate of 4 scfm/sf shall be supplied to ensure optimum cleaning.
  10. The washwater troughs shall be as described in the contract plans and specifications. Trough carry off capacity shall be 2,880 gpm (m<sup>3</sup>/h) with a freeboard of at least 2 inches. Adjustable straight edge weir plates, if required, shall be of fiberglass reinforced polyester laminate made by the matched die method.
  11. A complete filter control system shall be provided for controlling and monitoring the operation of the filter system. The control system shall be supplied by the filter equipment supplier and shall include all instrumentation, equipment, and programming required for a complete and operational filter control system
- B. Design Flow Rates: The filter underdrain system shall be furnished and installed to perform satisfactorily and as specified when operated under the following conditions:
1. Downflow of filtered water up to 10 gpm/sf (24.5 m/h).

2. Upflow of backwash air at a rate in the range of 2 to 5 scfm/sf (36.6 to 91.5 m/h).
  3. Upflow of backwash air, together with backwash water. Typical recommended combined air and water rates: 4 scfm/sf (73.2 m/h) and 5 gpm/sf (12.3 m/h). (Confirm other combinations with the factory).
  4. Upflow of backwash water up to 25 gpm/sf (61 m/h). (Contact the factory for higher rates).
- C. Flow Distribution: The filter underdrain system, as installed, shall provide acceptable flow uniformity. Maldistribution (MD) of air and water flows during backwash shall be as follows:
1. Lateral Water MD: The maldistribution in a lateral 32 feet (9.75 m) long or less shall not exceed +/- 3 percent of the average gpm/sf of filter for a backwash rate of 20 gpm/sf (48.9 m/h).
  2. Flume Water MD: Note, additional maldistribution, due to specific flume arrangement, entry conditions into both flume and underdrain laterals and flow velocities, must be considered.
  3. System Air MD: Visually, the air should show a uniform pattern.
- D. Structural Design Requirements
1. General: The filter underdrain system, including anchorage, supports, etc. shall be designed to safely withstand loadings for the specified conditions.
  2. Internal Loading: The filter underdrain system, when installed, shall be designed for a net internal loading during backwash of the greater of either 1400 psf (67 kPa) or 200 percent of the maximum pressure at maximum backwash rates. No credit shall be taken for the weight of gravel or filter media.
  3. Downward Load: The filter underdrain system shall also be designed to withstand a net downward loading of not less than 2,800 psf (134 kPa).



- E. Air Temperature: During backwash with air, the underdrain shall be suitable to withstand a maximum air temperature of 200° F (93°C).

### 1.3 QUALITY ASSURANCE

- A. Manufacturer: The underdrain system for the filters shall be the Leopold Type XA as manufactured by Xylem Water Solutions Zelienople LLC, Zelienople, Pennsylvania.
- B. Experience: The underdrain system shall be a standard product of a filter manufacturer who has been actively providing dual-parallel lateral air/water underdrain equipment for at least 35 years. Upon request, the filter manufacturer will provide the ENGINEER with a list of installations of similar dual parallel lateral underdrain which totals not less than 200.
- C. NSF Certification: All materials used in contact with the water and backwash air shall meet National Sanitation Foundation (NSF) Standard 61 Drinking Water System Components - Health Effects.
- D. Underdrain: The dual-parallel block units with integral flow metering elements and any specialties required for installation such as special anchorage, grout retaining bridges, closures, gaskets, etc., shall be the products of a single manufacturer/supplier.
- E. Uplift Certification:
  - 1. The underdrain manufacturer shall provide third party certification that the underdrain can withstand a minimum of 30 psi internal pressure without lifting or separating from the filter floor when properly installed with grout and no mechanical anchoring.
- F. Hydraulic Demonstration
  - 1. The underdrain manufacturer shall, at their own facilities, if requested by the ENGINEER, set up a test lateral run of equal length to that required by the project and provide an opportunity for the ENGINEER and/or OWNER to visit the facility to witness a full scale demonstration of the headloss and flow distribution during backwash.
  - 2. The test facility shall be capable of demonstrating concurrent air and water distribution in a submerged trough and water only distribution on a non-submerged test bench.

3. These demonstration services shall be provided by the filter manufacturer with reasonable notice and at no additional expense to the OWNER or ENGINEER.
- G. Media: The filter equipment manufacturer shall furnish a Quality Control Manual demonstrating that the filter media to be furnished will comply with the requirements of the contract specifications. The Quality Control Manual will define the following:
1. Qualification of the raw feedstock
  2. Control procedures at the screening mill
  3. Independent testing laboratories
  4. Packaging definition
  5. Purchase orders
  6. Storage procedures
- H. Filter Control System: The filter control system shall be supplied by the filter system manufacturer and shall be a standard product of the manufacturer. The control system shall be the FilterWorx® Automatic Control System as supplied by Leopold, a Xylem brand.
- I. Positive-Displacement Blower
1. The blower system(s) will be built by a blower system supplier who has units at 50 or more water treatment plants, the same size or larger than those specified below, that have been in successful operation for fifteen or more years.
  2. All components shall be furnished by a single supplier who shall be responsible for the performance and compatibility of the system.
  3. The blower system manufacturer shall be an authorized warranty service center for the bare blower provided.
  4. Unnamed manufacturers shall provide a complete technical submittal to the engineer for review at least 15 days prior to the published bid date noting all project specific system performances, curves, drawings, maintenance requirements, and any non-compliances with the specification to qualify for use on the project.
  5. Blowers, motors, and all primary components shall be manufactured in the United States with replacements and parts available from multiple sources within the United States.

#### 1.4 SUBMITTALS

- A. Submit to the engineer complete shop drawings showing details of fabrication, materials of construction, installation and leveling data of all items furnished under this section.

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- B. Details submitted shall include as a minimum, headloss data for air, water and combined air/water backwash, installation details, flow distribution calculations, certification of compatibility of the underdrain system with the filter media specified in this section, details for installing reinforcing and other items to be embedded in concrete.
- C. Testing Procedures: Detailed start-up, hydraulic, and air scour test procedures.
- D. Proper documentation showing NSF-61 certification of all underdrain components.
- E. The media submittal and technical information will be provided and approved by a licensed engineer regularly employed by the filter manufacturer. The engineer shall have at least 15 years experience in water treatment. All submittal shall include the following information as a minimum:
  - 1. Supplier's Name
  - 2. Resume of Engineer Providing Submittal
  - 3. Quality Control Manual
  - 4. Gradation of Each Media Type
  - 5. Date of Sampling/Lot Number
  - 6. Samples of Each Media Type (If Required)
  - 7. Representative Sample Analysis, (i.e. effective size, uniformity coefficient, specific gravity, acid solubility and MOH hardness for Anthracite only.)
  - 8. Material Quantities
  - 9. Diagram with Type of Material and Depth of Each
  - 10. Estimated Shipping Schedule
  - 11. Media Loading Procedure
  - 12. All testing shall conform to the requirements of the latest edition of AWWA B100.
- F. Wash Water Trough Testing
  - 1. Manufacturer shall, upon request, furnish the Engineer with certified test reports consisting of the mechanical and physical tests listed below.
  - 2. Procedure to be used in determining the properties listed in Table 1 below shall be in accordance with latest ASTM standards: Ultimate Tensile Strength - ASTM Designation D638; Flexural Strength - ASTM Designation D790; Modulus of Elasticity - ASTM Designation D790; Hardness - ASTM Designation D2583; Water Absorption - ASTM Designation D570.
  - 3. Hardness tests shall be made on the resin-rich surface of the product.
  - 4. Flexural tests shall be made with resin-rich surface in compression.
  - 5. Test samples shall be full thickness of the item produced and shall not be machined on the surface.

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6. Mechanical and physical properties shall conform to those of Table 1 and according to ANSI-AWWA specification F101 Table 4 - Minimum Physical Properties of Laminates.

**TABLE 1**  
**LAMINATE MECHANICAL AND PHYSICAL PROPERTIES 73°F**

<u>ASTM Test Method</u>	<u>For 1/4" wall Thickness</u>	
Ultimate Tensile Strength PSI x 10 <sup>3</sup> (Kg/cm <sup>2</sup> ) min	D638	12 (844)
Flexural Strength PSI x 10 <sup>3</sup> (Kg/cm <sup>2</sup> ) min	D790	19 (1336)
Flexural Modulus of Elasticity 10 <sup>3</sup> ) PSI x 10 <sup>6</sup> (Kg/cm <sup>2</sup> ) min	D790	0.9 (63.3 x
Barcol Hardness (min)	D2583	35
Water Absorption - % (max.)	D570	0.2

G. Positive-Displacement Blower

1) BLOWER

- a. BHP at: normal system operating conditions
- b. Discharge temperature at ambient temperature and normal system operating conditions.
- c. L10 bearing life calculations for each bearing.

2) MOTOR

- a. 1/2, 3/4, full load efficiencies and power factors
- b. L10 bearing life calculations for each bearing.

3) SILENCERS

- a. An attenuation performance curve for each type of silencer.

- 4) PRESSURE RELIEF VALVE
  - a. Set pressure
- 5) Shop drawings of assembled system stating what items will be shipped to the job site assembled and those shipped loose for field assembly.
- 6) V-belt Coupling drive calculations.
- 7) A list of all exceptions and an explanation of each non-compliance with the specifications.

**1.5 SHIPMENTS**

- A. Media materials will not be shipped until the submittal is approved by the Owner. Approval of the submittal, including the Quality Control Manual, samples and independent testing, shall constitute acceptance of the media.
- B. The schedule of work shall be submitted to the Owner for approval prior to commencement of work.
- C. The contractor shall be responsible for coordinating the shipment of supplies of materials and equipment specified herein. Coordination will be required during construction, startup and/or testing.
- D. The Owner shall provide storage space for gravel and filter media and protect it from exposure to sunlight if stored for more than two weeks. Paper bags (if used) shall be protected from moisture at all times.
- E. The contractor shall be responsible for storage of the filter control system equipment. The storage area shall be indoors, reasonably dust-free and protected from exposure to water or any corrosive materials.

**PART 2.0 PRODUCTS**

- A. Underdrain
  1. The underdrain system for the filters shall be a dual parallel lateral whereby feeder and compensating chambers are provided within the cross section of a single block. The cross section of the underdrain shall be where the feeder (or primary) chamber is adjacent and connected to the compensating (or secondary) chambers through a series of orifices. The orifices shall be located at four different elevations and sized to provide uniform distribution of air and water. All internal orifices shall be integrally molded to provide a smooth bore orifice. Underdrains requiring secondary drilling procedures to install internal orifices and underdrains with circular water orifices in the primary chamber will not be considered acceptable. The primary chamber should provide at least 43 square

inches (277 square cm) of cross sectional area per block to reduce flow velocity during backwash.

2. The compensating chambers shall provide the essential uniform pressure and flow distribution from the top of the blocks. The discharge flow from the top of the blocks into the filter bed shall be provided by approximately twenty-three dispersion orifices per square foot of filter area. The orifices shall be not less than 11/64 inch (4.5 mm) diameter to prevent clogging and shall be recessed from the surface by approximately 1/8 inch (3.2 mm). The top of each orifice shall be encircled by a depression approximately 3/8 inch (9.5 mm) x 3/4 inch (19 mm), which shall act to prevent the gravel support media from resting directly on and thereby blocking the dispersion orifice.
3. The underdrain shall have a horizontal flat top discharge surface, so that the finished filter bottom is essentially flat, with above stated dispersion orifices for uniform energy intensity of air and water coverage which direct flow vertically for effective penetration and cleaning of the media.
4. Dual water recovery channels with return holes shall be incorporated into the top of the underdrain block to ensure uniform and continuous air flow from the top deck orifices and greater air stability. Underdrains without a water recovery channel will not be considered acceptable.
5. The secondary chambers of the underdrain shall have baffles sized and located to provide effective air control and to reduce level sensitivity. Underdrains without baffles will not be considered.
6. The secondary chambers of the underdrain shall have baffles sized and located vertically along the exterior of the primary chamber to provide effective air and water control.
7. The underdrain shall have a lug located on the exterior of the underdrain to allow simple connection and disconnection of an optional handle. The optional handle shall be removed once the filter laterals are set in place within the filter tank.

**B. Air Header**

1. Because the proper distribution of air into the underdrain has a significant effect upon operation, the filter manufacturer shall have the responsibility to design and provide the air distribution header for this underdrain.

**C. Filter Media**

1. Filter sand shall be composed of hard, durable clean siliceous particles, free of all mica with an average specific gravity of 2.6 ( $\pm 0.05$ ) and shall be in strict accordance with AWWA B100, and have an effective size of 0.50 mm, and a uniformity coefficient of 1.40 or less, for a finished depth after backwashing and scraping and removal of fines and debris of 12 inches.

For depths up to 12 inches (305 mm), a 1/2-inch (13 mm) skimming allowance shall be provided.

2. Filter anthracite shall be composed of specially selected and graded hard, durable anthracite coal particles. The anthracite shall be composed entirely of deep mined material. A quality control manual shall be included to show the source of the material and the quality of the material produced. The anthracite shall have an average specific gravity of 1.65 ( $\pm 0.05$ ) with a hardness (Mohs' scale) of 2.7 or more and shall be essentially free of iron, clay, shale, extraneous dirt, and excessive dust with moisture less than 4.0 percent as shipped. The anthracite shall be in accordance with AWWA B100, and have an effective size of 1.00 mm, and a uniformity coefficient of 1.40 or less for a finished depth after backwashing and scraping and removal of fines and debris of 24 inches. A skimming allowance of 1 inch (25 mm) shall be provided.

D. Fiberglass Wash Water Troughs

1. Loadings - The troughs shall be designed to support, within stress and deflection limitation, the following loadings:
  - a. Gravity Load - Downward vertical loads shall include the weight of the trough and appurtenant attachments, such as weir plates and the spreader bars, together with the weight of water to fill the trough. Any additional loads, such as piping, etc., shall also be considered.
  - b. Buoyant Load - The buoyant load shall act vertically upward, its magnitude equal to the weight of displaced water (trough weight neglected). The line of action passes through the centroid of the submerged cross-sectional area.
  - c. Lateral Load - Loads acting against the trough side walls; specifically, those induced by differential water levels on either side of the trough walls. The maximum possible differential, existing when the trough is empty and the tank is full, or when the trough is full and when the tank is empty, shall be used when calculating deflection, fiber stress, etc.
2. Thermal Stresses - The troughs shall be designed to accommodate temperature induced stresses resulting from differences in coefficients of thermal expansion (contraction) between the trough and tank/support materials.
3. Torsional Stability - The trough system shall be designed to resist torsional oscillations induced by the flow of water over trough edges. Any or all of the following trough stabilization techniques shall be considered.
  - \* Trough-to-trough stabilization
  - \* Torsional stiffness
  - \* Support spacing and rigidity
  - \* Internal baffles and/or flow straighteners

4. Deflection Under Load - Maximum vertical deflection under full buoyant or gravity load shall be less than or equal to  $L/1000$ , where  $L$  is defined as the unsupported trough length in inches (mm). Under no circumstances shall the maximum vertical deflection, measured at mid-point between trough supports, exceed 3/16 inch (4.8 mm).

Maximum trough side wall horizontal deflection under full lateral load shall be less than or equal to  $D/100$ , where  $D$  is defined as the trough depth, in inches (mm). Under no circumstances shall the maximum bottom deflection exceed 3/16 inch (4.8 mm).

Trough bottom deflection (oil canning) under full buoyant or gravity load shall be less than or equal to  $W/100$ , where  $W$  is defined as the trough width, in inches (mm). Under no circumstances shall the maximum bottom deflection exceed 3/16 inch (4.8 mm).

5. Fiber Stress Limitations - Supplemental to the deflection criteria, the troughs shall also be designed such that the maximum wall stress under the most severe loading conditions is less than or equal to 1500 psi (103 bars). This stress criterion is equivalent to 7:1 safety factor (approximate) as applied to the tensile and flexural properties of contact molded troughs and launders.
6. Thermal Expansion/Contraction - The troughs shall be designed to accommodate a thermally induced expansion (contraction) of 1/8 inch (3.2 mm) per 20 feet (6.1 m) length of trough over temperature range of 10°F (-12°C) to 100°F (38°C), without exceeding the deflection or strain limitations set forth in the preceding sections.

**E. Filter Control System**

1. A complete filter control system shall be provided. The control system shall be the FilterWorx® Automatic Control System and shall include all equipment and instrumentation required for a complete and operational filter system. As a minimum, the control system shall consist of the following:

Two AFC®5000 Dual Filter Control Consoles (one for two filters)

Four magnetic flowmeters (one for each filter effluent & one for backwash)

One (1) lot of field instrumentation as outlined in paragraph 2.1 of this section

One (1) FilterView™ operator workstation complete with software

All equipment and instrumentation shall be supplied in accordance with the requirements in paragraph 2.1 of this section.

**F. Positive-Displacement Blower**



1. The blower system(s) shall be manufactured by Kaeser Blowers.

## 2.1 MATERIALS AND CONSTRUCTION

### A. Underdrain

1. **Material:** The individual blocks used in the system shall be of impervious high strength, completely corrosion-resistant, high-density polyethylene (HDPE) material. The blocks shall be resistant to erosion and corrosion and have uniform smooth surfaces.
2. **Dimensions:** The block size and weight shall permit ease of handling and installation. The block nominal dimensions shall be 8.25 inches high by 11 inches wide by 48 inches long. The weight of the block shall be approximately 24.5 pounds. Underdrains with heights greater than 8.25 inches (209 mm) shall not be allowed.
3. **Block Geometry:** The blocks shall be essentially rectangular in shape with dispersion orifices located in the top flat surface. The blocks shall have ridges and pockets for structural rigidity. The sides of the block shall have grout lock-in lugs to key into surrounding grout so that the walls can bond with the grout. The bottom of the block shall have integral grout pockets located at each end.
4. **Lateral Construction:** The blocks shall be arranged end-to-end and mechanically joined to form continuous underdrain laterals approximately equivalent to the length of the filter cell. The joints shall be gasketed, bell and spigot type with internal alignment tabs for proper joint alignment, and be air and water-tight. Joints shall be of snap-lock type so that the blocks are joined with integral interlocking snap lugs and lug receptors for ease of assembly and installation.
5. **I.M.S® 200:** The I.M.S® 200 media retainer shall be made of thermoplastic through the injection molded process and sealed to the top of the underdrain. The I.M.S® 200 media retainer shall be made from two separate sections that are permanently sealed together to form slots or openings. The opening size shall be sufficient to prevent the media from obstructing or passing through the underdrain. Vertical baffles shall be located on the bottom side of the media retainer to “compartmentalize” the fluid to keep it from moving horizontally along the bottom side of the media retainer thus ensuring each pattern of slots in the media retainer receives equal quantities of air and or water during the backwash cycle. The I.M.S® 200 media retainer shall replace the need for support gravel and shall not increase the underdrain height by more than 1 1/4 inch. The cap shall be attached and sealed to the underdrain at the factory using Type 316 stainless steel self tapping screws and 3M Weatherban Sealant Tape.

## 6. Positive-Displacement Blower:

IMPELLERS:	Involute design; cast or ductile iron; static and dynamically balanced; operate without rubbing, liquid seals or lubrication.
SHAFTS:	One piece steel that pass through the impellers or stub shaft cast integrally with the impellers.
TIMING GEARS:	Spur or helical tooth; alloy steel; held by taper pins, wedge rings, or bolted to timing hubs spline mounted to the shafts.
LUBRICATION:	Gear end oil splash, other end grease or oil splash.
SEALS:	Labyrinth or lip on each bearing with air vents between seals and impeller chamber.

## B. Grout

1. Cement: Cement shall be standard brand Portland cement conforming to ASTM C150, Type II, for general use. Cement that has become "lumpy" shall not be used.
2. Water: Water for mixing and curing shall be clean and clear potable water. The water shall be considered potable if it meets the requirements of the local government agencies. Water with a total dissolved solids of 1000 mg/l or higher or greater than 10 NTU shall not be used.
3. Sand: Sand shall be clean and washed masonry sand. When tested in accordance with ASTM D2419, the sand equivalency shall not be less than 90% for an average of three samples, or less than 85% for any individual sample. 100% of sand particles shall pass No. 4 sieve and not more than 4% of sand particles shall pass No. 200 sieve.
4. Chemical Admixtures: No chemical admixture is needed in most of the applications. The grout can be mixed in a small batch and used immediately.
5. Strength: The grout used in installing the blocks shall have a minimum compressive strength of 3000 psi after 30 days of curing. Normally, use a grout with one part Portland cement and two parts clean silica sand properly mixed and wetted with a maximum water-cement ratio by weight equal to 0.50 to 0.55 for the base grout and 0.61 to 0.67 for the fill grout.

## C. Wash Water Troughs:

1. Resin: The resin shall be a commercial grade, general purpose polyester thermosetting resin, which has either been evaluated in a laminate, or

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which has been determined by a previous documented service to be acceptable for the service conditions. Contact the factory for specific chemical resistant applications.

a. The resin shall contain no fillers except as follows:

\* A thixotropic agent which does not interfere with laminate quality, or with the required chemical resistance of the laminate, may be added for viscosity control.

\* Resin may contain pigments, dyes or colorants which have been determined by at least five (5) years previous service to be acceptable for the service condition without fading or chalking from original color standard.

2. Ultraviolet Resistance: All laminates have ultraviolet resistance in the form of pigmentation or ultraviolet absorbers.
3. Metal Reinforcement: When metal reinforcements are used, they shall be free of rust, oil, and any foreign matter. They shall be completely encapsulated with a minimum of 1/8-inch thick laminate.
4. Glass Reinforcement: Glass reinforcements shall consist of chemically bonded surfacing mat and chopped strand or chopped strand mat as hereinafter described. Surfacing mat shall be type C, 10-20 mils thick, with a silane finish and a styrene-soluble binder. Chopped strands shall be Type E glass, with silane finish and styrene-soluble binder. The glass content of the finished laminate shall be adequate to produce mechanical and physical properties conforming to Table 1.
5. Manufacture:
  - a. The inner surface of the trough shall be smooth and resin rich. The outer surface shall be reasonably smooth and no glass fibers shall be exposed. The size and number of air bubbles shall be held to a minimum. Laminations shall be dense and without voids, dry spots, cracks or crazes.
  - b. The inner surface of the trough shall be reinforced with glass surfacing mat. This shall be followed with chopped strand glass laminate (max. 2 oz. per sq. ft.) in a minimum of two (2) layers. Void content of the complete laminate shall not exceed 2 ½ % of laminate volume.
  - c. The top edges of the trough shall be level and parallel with a tolerance of plus or minus 1/8 inch (measured when the trough is not loaded). The length of a trough section shall have a tolerance of ±1/8-inch per 10 feet length. The laminate thickness tolerance shall be plus 1/8 inch minus 0.

- d. Thickness at locations of supports such as saddles shall be at least 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of the specification.
- e. End flanges and blind ends shall be a minimum of 1 ½ times the nominal thickness of the trough and shall conform to the fiber stress limitations set forth in the design section of this specification.
- f. An integrally molded water stop shall be provided on the trough whenever the trough is grouted into and/or passes through a wall.
- g. One-inch diameter ABS spreaders shall be bolted between the trough walls on approximate 2 feet centers to enhance the structural rigidity of the trough system.

**D. Filter Control System**

**1. Filter Control Console**

- a. A Filter Control Console shall be provided for controlling and monitoring the operation of each filter.
- b. Each console shall be a PLC-based system and shall be provided complete with the necessary control devices, equipment, and functional programming to perform the control and monitoring functions specified.
- c. The Filter Control Console shall be an AFC 5000 as manufactured by Leopold, a Xylem brand or equal.
- d. Functional Description
  - 1. Each console shall have the capability of controlling the filtration and backwash sequence for a single filter. It shall have the capability for semi-automatic, automatic, and manual control.
  - 2. In the automatic mode, the backwash sequence shall be initiated by high turbidity, high loss-of-head, or exhausted filter runtime. The PLC shall perform the backwash sequence without operator intervention.
  - 3. In the semi-automatic mode, the backwash sequence shall be manually initiated by the operator following a system alert based on the above mentioned conditions. Occurrence of any of these conditions shall illuminate the BACKWASH REQUIRED pilot light. The operator shall initiate the backwash sequence by pressing the START BACKWASH pushbutton. The PLC shall then perform the backwash sequence without further operator intervention. An ABORT BACKWASH pushbutton shall be provided to end the backwash sequence before its completion.

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The console shall include an EXTEND HIGH BACKWASH pushbutton that will extend the high rate backwash for an adjustable amount of time.

4. In the manual mode, the backwash sequence shall be completely manual in operation, using the selector switches and indicators on the console. Manual operation shall be independent of the PLC.
5. An electronic valve positioner/controller shall be provided for the effluent control valves. The valve positioner/controller shall include AUTO/MANUAL and an INCREASE/DECREASE buttons. In AUTO mode, the unit shall accept a remote setpoint signal and position the flow control valve to maintain the flow setpoint. The remote effluent flow setpoint to each filter shall be generated by a common influent channel level transmitter. Backwash flow control shall be accomplished from varying the backwash pump speed via the VFD in the motor control center. The remote backwash flow setpoint shall be generated from an output signal from the filter PLC based on the current backwash step. In MANUAL mode, the flow will be adjusted manually by pressing the appropriate INCREASE/DECREASE button. The unit shall have a dual LED display for indicating the flow setpoint and the actual flow in GPM.
6. The console shall have OPEN/HOLD/CLOSE selector switches for manual control of the effluent, backwash control and air scour vent valves. The console shall have OPEN/CLOSE selector switches for manual control of the influent, drain, backwash inlet, air scour inlet, and filter-to-waste valves. It shall also have START/STOP selector switches for the air scour blower(s) and backwash pump(s).
7. The console shall include an operator interface touchpad to monitor the operation of the PLC and adjust the system setpoints.
8. The console shall provide dry-contact open and dry-contact close outputs for each valve controlled from the console. It shall accept dry-contact limit switch inputs from each valve and shall have pilot lights for indication of fully opened and fully closed position. Motors shall be controlled via a single maintained dry-contact that shall close when the motor is to run. The console shall accept a dry-contact running signal for proof that the motor is running.
9. Digital indicators shall be provided for loss of head and turbidity.
10. NOTE: The contractor shall be responsible for ensuring that equipment supplied by others includes the necessary and proper signal interface.

**e. Components**

1. The enclosure shall be a totally enclosed, sloped top console, 48 inches (122 cm) in width. It shall be manufactured of fiberglass reinforced plastic (FRP) having a minimum wall thickness of 1/8 inch (3 mm). The console enclosure shall be a model FCP as manufactured by Leopold, a Xylem brand.
2. The electronic valve positioner/controllers shall be Leopold model Valve PAC® series II.
3. The operator interface touchpad shall be Magelis model XBT.
4. Selector switches, pushbuttons, and pilot lights shall be Square D, Type ZB4, or equal. Pilot lights and illuminated pushbuttons shall be LED type.
5. Digital indicators shall be Red Lion "IMP" series, Modutec 2000 series, or equal.
6. Control relays shall be general purpose, plug-in type with LED pilot indicator, Square D, Class 8501, Type K or Type R, or equal.
7. Terminal blocks shall be Weidmuller WDU 4 series, or equal.
8. Circuit breakers shall be Square D, Class 9080, Type GCB, or equal.
9. The PLC system shall be a modular type and shall be designed to have 10% active spare input/output terminations at each register or remote I/O rack. Spare I/O shall be wired to terminal blocks. The PLC shall have an Ethernet port for communications. The PLC system hardware shall be Modicon Premium or Allen-Bradley Compactlogix series. Final PLC selection shall be coordinated with plant-wide system integrator.

**f. Wiring**

1. The console shall be completely pre-wired except for wires to external devices, which shall be brought to lugless tubular screw with pressure plate terminal blocks. All wiring shall be in compliance with the National Electric Code (NEC).
2. Minimum wire size for 120 VAC power wiring shall be #16 AWG stranded copper conductor, 600V, 90 degrees C with thermoplastic insulation. Minimum wire size for 24 VDC power wiring shall be #18 AWG stranded copper conductor, with thermoplastic insulation. Minimum wire size for DC signal

wiring shall be #18 AWG twisted, shielded pair with drain wire (Belden 8760 or equal), and grounded in accordance with ISA Recommended Practice for signal wiring.

3. Wires shall be color coded as follows:

120 VAC, 2 wire, single phase:

Phase - L1, Black

Neutral-L2, White

Externally powered circuit - Yellow

120 VAC control - Red

24 VDC Control - Blue

Ground - Green, or green with yellow stripes.

E. Magnetic Flow Meters

1. The electromagnetic flow meter shall consist of a flow sensor based on Faraday's Law of Electromagnetic Induction and microprocessor-based signal converter, type MAG 5000 or equal..

2. Sensor:

- a. Operating principle: Utilizing Faraday's Law of Electromagnetic Induction, the flow of liquid through the sensor induces an electrical voltage that is proportional to the velocity of the flow.
- b. Construction: (choose based on sensor size)
  - i. (2" – 12") The sensor flow tube and liner material shall be constructed of a composite elastomer (hard and soft rubber) surrounded by two integral coils. Measurement and grounding electrodes shall be 316 stainless steel. Connecting flanges shall be carbon steel. Wetted materials shall be NSF approved for drinking water service.
  - ii. (1", 1-1/2", and 14" – 48") The sensor flow tube shall be 304 stainless steel surrounded by two coils. Liner material shall be hard rubber. Measurement and grounding electrodes shall be 316 stainless steel. Connecting flanges shall be carbon steel. Wetted materials shall be NSF approved for drinking water service.
- c. Installation:

A minimum of 5 pipe diameters up stream and 3 pipe diameters down stream are recommended (Consult the factory for any variations.).
- d. Operating Temp: -20 to +200° F.
- e. Size: 1" to 48" diameter (see instrument schedule)
- f. Submergence: The sensor shall be pedestal sealed against accidental submersion to 3 feet for 30 minutes standard, or permanently submerged to 30 feet when the terminal box is backfilled with a non-setting, transparent potting material.

3. Signal converter: Type MAG 5000.

- a. Enclosure: NEMA 4X enclosure
  - b. Display: Background illumination with alphanumeric 3-line, 20-character display to indicate flow rate, totaled values, settings, and faults (a blind version of the MAG 5000 signal converter is available).
  - c. Power supply: 115/230 VAC or 11-24VDC.
  - d. Operating temperature: -5 to +120 degrees F.
  - e. Outputs: 0-20 mA or 4-20 mA into 800 ohms max. One relay rated at 42 VAC/2 A, 24 DC/1 A. Digital (frequency or pulse) for external display of flow rate or totalizer.
  - f. Communications: Optional HART available.
4. Sensor and signal converter performance:
    - a. Flow Range: 1.5 fps to 33 fps for accuracies stated below.
    - b. Accuracy: 0.5% of actual flow.
    - c. Separation: Maximum distance of 900 feet between signal converter and sensor without the use of any additional equipment.
    - d. Bi-directional flow capabilities shall be standard
  5. Totalizer:
    - a. Two eight-digit counters for forward, net, or reverse flow
  6. The electromagnetic flow meter shall be a Siemens Model MAG 5100 W flow sensor with a Siemens Model MAG 5000 signal converter or equal.

**F. Field Instrumentation**

**1. Filter Loss of Head Transmitters**

- a. A loss of head transmitter, complete with three-valve manifold, mudleg and strainer, shall be supplied to monitor the loss of head through each filter.
- b. The transmitter shall be of compact design with external span and zero adjustments. Accuracy shall be  $\pm 0.25\%$  of calibrated span for a range of 20% to 100% of flow (4% to 100% of differential pressure).
- c. The loss of head transmitter shall be the Rosemount 3051 Smart DP, or approved equal.

**G. Filter Continuous Level Sensors**

- a. A level transmitter shall be provided for each filter.
- b. The filter level sensing system shall be an ultrasonic-type, electronic continuous level transmitter, complete with sensing element and integral electronics. The sensor shall be



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powered by a nominal 24 VDC loop power supply and shall generate a standard 4-20 mADC output signal.

- c. The level sensor shall be a Siemens SITRANS Probe LU Ultrasonic Level Transmitter or approved equal.

### H. Effluent Turbidimeters

- a. An effluent turbidity meter shall be provided for each filter. All filter turbidimeters shall as specified in Section 13601 subsection 2.4 and Section 11320 "Raw Water Analysis"

### I. Common Influent Channel Level Sensor

- a. A level transmitter shall be provided at the common filter influent channel for generation of the filter effluent rate of flow setpoint.
- b. The level sensing system shall be an ultrasonic-type, electronic continuous level transmitter, complete with sensing element and integral electronics. The sensor shall be powered by a nominal 24 VDC loop power supply and shall generate a standard 4-20 mADC output signal.
- c. The level sensor shall be a Siemens SITRANS Probe LU Ultrasonic Level Transmitter, or approved equal.

### J. SCADA System Interface

- a. The SCADA integrator shall furnish and program the HMI PC's specified in Section 13600 of the specifications. The filter manufacturer shall provide the SCADA integrator the following items for monitoring status and alarms in the filtration system from the SCADA HMI PC's via Ethernet I/P protocol:
  - i. Filter Control System PLC tag name data base
  - ii. Filter Control System Console Operator Interface data base and graphic screen files
- b. The filter manufacturer shall be responsible for all required PLC and Operator Interface drivers or converters to network with the SCADA integrator via Ethernet I/P protocol.

### K. Filter Control Valves

- 1. The following filter valves, complete with actuators, shall be supplied.

<u>Quantity</u>	<u>Function</u>	<u>Type</u>	<u>Service</u>
-----------------	-----------------	-------------	----------------

4	Influent	Electric	open/close
4	Effluent	Electric	modulating
4	Filter to waste	Electric	open/close
4	Backwash Waste	Electric	open/close
4	Backwash Inlet	Electric	open/close
4	Air Inlet	Electric	open/close
1	Air Vent	Electric	open/close

2. Should there be any conflict between the following valve and actuator descriptions and the previous noted sections, the noted sections shall apply.
3. Valve sizes shall be as indicated on the Contract Drawings. Valves shall meet the full requirements of AWWA Standard C504 for Class 150B.
4. The valve shall be of the tight-closing, rubber-seat type with rubber seats that are securely fastened to the valve body. No metal-to-metal surfaces shall be permitted. Valves shall be bubble-tight at rated pressures with flow in either direction, and shall be satisfactory for applications involving throttling service and/or frequent operation. Valve discs shall rotate 90 degrees from the full open position to the tight shut position.
5. All electric actuators shall conform to the requirements of AWWA Standard C540-93. Actuators shall contain motor, gearing, manual over-ride, limit switches, torque switches, drive coupling, integral motor controls, position feedback potentiometer for modulating service and mechanical dial position indicators

## **PART 3.0 EXECUTION**

### **3.1 PRODUCT HANDLING, STORAGE AND DELIVERY**

- A. Place or store underdrains and specialties only in designated staging areas shown on the drawings and approved by the Engineer.
- B. Store underdrains and specialties off the ground, under ultraviolet-resistant tarps from time of delivery on-site until final installation of the filters.
- C. Replace, at no charge to Owner, underdrains and specialties damaged during storage and delivery.
- D. Underdrains and specialties are subject to inspection at the Engineer's request if visual evidence of damage is observed.

- E. All filter media will be shipped in "semi-bulk" containers having lifting loops and bottom discharge spout. Anthracite superbags are 60 cubic feet (1.7 cubic meters) weighing approximately 3,000 pounds each.
- F. Delivery of "bulk" shipments will not be permitted unless the contractor can demonstrate that the materials can be handled and stored without contamination
- G. Troughs shall be suitably packaged to avoid damage during handling and shipment. Should it be necessary to store product prior to installation, precautions should be taken to prevent warpage or distortion.
- H. Troughs should be stored on a flat place and adequately supported on wooden support members to evenly distribute weight of troughs. When stored more than one (1) high, succeeding items should be stored level and evenly supported by blocks or spacers.

### 3.2 INSTALLATION

#### A. Filter Underdrains and Air Header

1. The CONTRACTOR shall install the filter underdrain system in strict accordance with: (1) the manufacturer's written instructions and recommendations and the manufacturer's installation drawings; (2) the oral and written directions provided by the manufacturer's technical representative who is supervising and observing the WORK; and (3) any additional requirements specified herein.
2. Floor Preparation
  - a. Care shall be exercised in preparing the filter floor slab and in setting the anchors to assure proper alignment and elevation. Steel anchor rods shall be furnished by the filter manufacturer and set in the floor slab on both sides of the distribution flume in accordance with the drawing provided. The floor slab shall be screeded into a flat level plane and be free of protrusions and depressions, but have a rough, broom finish. Do not trowel or finish the floor to a smooth finish.
  - b. DO NOT PAINT the floor or wall area where it will come in contact with the grout surrounding the underdrain. The filter floor and filter wall extending sixteen (16) inches (406 mm) up from the filter floor is not to be painted.
3. Underdrain Lateral Installation
  - a. The underdrain laterals shall be set in relatively level rows on a bed of grout over the filter floor slab. Plates for closing the ends of each row of blocks shall be furnished by the filter manufacturer and installed by the CONTRACTOR. After joining, aligning and setting the blocks, and the bed grout is set-up, as soon as possible, all spaces between the rows of blocks and walls shall be filled with grout so that the entire

bed is totally sealed and held firmly in place. Once all grouting is complete, the grout shall be allowed to cure for at least 3 full days before any functional testing.

- b. Anchor rods, if required as shown in the contract drawings, shall be supplied by the underdrain MANUFACTURER and installed by the CONTRACTOR. Installation of the anchor rods shall be in accordance with the MANUFACTURER'S approved installation drawings and instruction manual.
  - c. After the anchor rods have been installed and the epoxy has cured, a non-destructive vertical pull test shall be performed. Testing shall be performed on 100% of the anchor rods. The pull test shall be performed by the underdrain MANUFACTURER in accordance with the MANUFACTURER'S instruction manual.
4. Cleaning and Protection During Installation, Testing, and Startup
- a. The CONTRACTOR shall take all precautions recommended by the underdrain manufacturer or specified herein to ensure that the filter underdrain system and any piping communicating therewith is completely clean and free of any debris, dirt, or other foreign materials which could clog the underdrain system or interfere with flow. Backwash air and water piping shall be thoroughly flushed clean. All loose debris and dirt within the filter cell and flume shall be removed by brooming down and vacuuming. Care shall be taken to keep grout from being deposited anywhere where it could interfere with flow. Any grout so deposited shall be removed. As installation progresses, partially completed portions of the WORK shall be protected with heavy plastic sheeting or other suitable material to maintain the cleanliness of the underdrain system. Such protection shall be maintained until the support gravel is installed.
  - b. Any time the underdrain laterals are to be used as a work surface, the underdrain block shall be overlaid with ½ inch minimum plywood sheeting where necessary, to distribute the load of yard buckets, wheel barrows, ladders, scaffolds, etc., to prevent damage to the underdrain.

**B. Media**

- 1. Marks shall be placed on the side of the filter designating the top elevation of each layer.
- 2. Carefully place each layer so as not to disturb the previous layers.
- 3. Complete the installation of each layer before the next layer above is started. Do not stand or walk directly upon the filter materials. Workers must stand or walk on boards that will sustain their weight without displacing the gravel and media.

4. Measure depth of each layer of media after it has been backwashed and skimmed as recommended by the filter equipment manufacturer.
5. Clean the filter tanks before any media is placed and keep them clean throughout the placing operation.
6. Filter Sand: Place the filter sand in the bed in the order of their respective specific gravities. Place and level the filter sand first. Then backwash the bed a minimum of three times, and remove the surface fines by scraping as required to the correct elevation. Place the filter GAC and backwash the bed three times, and remove the surface fines by scraping as required to the correct elevation.

**C. Wash Water Troughs**

1. All trough mounting brackets, hardware and stabilizers shall be Type 18-8 stainless steel and shall be supplied by the trough manufacturer.
2. Troughs shall be installed so that the trough weir edges are level to within  $\pm 1/8$  inch.

**D. Filter Controls and Instrumentation**

1. The contractor shall be responsible for installation of the filter control consoles and all wiring from the console to field devices, instruments, and other systems.
2. Start-up shall be performed with all final elements, field devices, and instruments installed, calibrated, and wired in the circuit.

**E. Positive-Displacement Blowers**

1. Blowers are recommended to be installed on a non-moving foundation with the industry standard depth of twice the blower gear diameter or a pad 2 times the total mass of all rotating components, whichever depth is greater.
2. If these recommendations cannot be accommodated, the following points must be followed to ensure an adequate installation:
  - a. The blower pad must be located on the equivalent of compacted soil substructure, which will allow the pad to remain flat, rigid, and free of resonant frequencies within the operating range of the equipment.
  - b. The blower must be anchored using bolts intended specifically for dynamic loading.
  - c. The area between the base and pad must be filled with 1" minimum non-shrink grout.
  - d. The unit must be installed and leveled per the manufacturer's instructions supplied in the O&M manual.

**3.3 FIELD TESTING**

**A. Underdrain Lateral Flow Distribution Test**

1. The filter underdrain system in each filter cell shall be given a series of visual, qualitative, flow distribution tests to verify that I.M.S.® Cap pores are not clogged with debris and that flow distribution is uniform. These tests shall be performed before the filter media is placed.
2. During each test, the underdrain laterals shall be visually inspected for uniform distribution of air and water and for any signs of quiescent zones and excessive surface turbulence.

**B. Positive-Displacement Blower**

1. The blower system supplier shall provide the services of a factory trained technician to check installation, verify proper operation and train the owner's personnel in proper maintenance procedures. Start-up services shall be a minimum of one day.

**3.4 MANUFACTURER'S SERVICES**

**A. Mechanical Filter Equipment Services**

1. Install all items in accordance with the filter equipment manufacturer's recommendations. Upon completion of the installation, the technical director shall furnish a certificate of compliance detailing that the filtering materials have been installed in accordance with the manufacturer's instructions.
2. The underdrain manufacturer shall retain on its permanent staff, field service representatives with at least 10 years of experience in the placement of underdrain. (Such persons shall be available on a fee-paid basis to instruct the CONTRACTOR in the proper placement and testing of the underdrain).
3. The CONTRACTOR shall provide the services of the manufacturer's technical representative for not less than twenty (20) working days (8 hours per day) including travel to inspect and supervise the installation and testing of the filter underdrain system in four (4) trips.
4. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses.

**B. Controls and Instrumentation Services**

1. The control system manufacturer shall provide a technical representative to assist the contractor's personnel with the startup for not less than fifteen (15) working days (8 hours per day) including travel in three (3) trips. The factory service technician shall have a minimum of five years experience in the start-up of air/water filter backwash systems.
2. On-site training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the hardware and to instruct them in day-to-day operations of the controls, preventative and regular maintenance, trouble shooting techniques, and system diagnostics.
3. Additional supervision for testing or other purposes in excess of that included above shall be made available by the manufacturer with reasonable notice and at the manufacturer's prevailing per diem rate plus living and travel expenses

**3.5 DISINFECTION**

- A. After all work is completed and before the filter is placed in service, the owner will disinfect the entire filter by chlorination in accordance with ANSI/AWWA C653 Standard.

**3.6 DOCUMENTATION**

- A. As a minimum, documentation shall include:
  - Complete console shop drawings showing layouts, schematics, and interconnections among field mounted equipment and other systems
  - Manufacturers' standard instruction bulletins for all functional components

**3.7 SPARES**

- A. Spares shall be provided as follows:
  - Ten (10) underdrain o-rings.
  - Five (5) H.I.P.S bridging pieces.
  - Five (5) Plastic end caps.
  - Two (2) of each switch, push-button and light used
  - Two (2) of each type of relay used.
  - One (1) of each type of PLC I/O card used.
  - One (1) of each type of PLC power supply used.

\*\*\* END OF SECTION \*\*\*

**SECTION 12100**  
**WINDOW TREATMENT**

**PART 1 GENERAL**

1.01 REQUIREMENTS INCLUDED

- A. Furnish and install window blinds on window framing system.

1.02 RELATED REQUIREMENTS

- A. Section 08400: Window Framing System.

1.03 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01300.

**PART 2 PRODUCTS**

2.01 MATERIALS

- A. Window blinds: Levelor mini-blinds.
- B. Color: Selected from standard range.

**PART 3 EXECUTION**

3.01 INSTALLATION

- A. Mount on solid backing. Where mounting locations do not align with solid backing, provide expanded gypsum board type anchors for each screw hole location.
- B. Clean and adjust for proper operation.

END OF SECTION



## **SECTION 13500**

### **PRE-ENGINEERED STRUCTURE**

#### **PART 1 GENERAL**

##### **1.01 REQUIREMENTS INCLUDED.**

- A. Primary and secondary framing.
- B. Connection bolts.
- C. Manufacturer's standard siding.
- D. Manufacturer's standard mechanically seamed, standing seam roofing.
- E. Insulation.
- F. Flashing, trim, closures, gutters, downspouts and fasteners.
- G. Erection.

##### **1.02 RELATED REQUIREMENTS**

- A. Section 03100: Concrete Formwork
- B. Section 03200: Concrete Reinforcement.
- C. Section 03300: Cast-In-Place Concrete.
- D. Section 07900: Sealants.

##### **1.03 SUBMITTALS**

- A. Submit shop drawings, calculations and product data in accordance with Section 01300.
- B. Indicate anchor bolt sizes and setting plans, sidewall and roof framing, details covering siding, roofing, flashing and installation.
- C. Indicate the following information:  
Building Design                      Foundation Design

Dead loads	Dead load
Live loads	Live load
Special equipment loads	Wind loads
Design wind velocity and loads	Maximum design
Seismic loads	Seismic

- D Guarantees.
- E Foundation loads.

#### 1.04 QUALITY ASSURANCE

- A. Pre-engineered structure manufacturer Butler, Varco-Pruden or approved equal.
- B. Qualifications of erector. Erector shall have been regularly engaged in similar work for a minimum of five years.
- C. Qualifications of welders: Welders shall be qualified in accordance with AWS D1.1.
- D. Certifications: Manufacturer shall certify that:
  - 1. The structure conforms to the requirements indicated on the Drawings and specified herein.
  - 2. The steel used in the fabrication is the same grade as allowed for in the manufacturer's design.
  - 3. After inspection, the building has been erected in accordance with the design.

#### 1.05 REFERENCES

- A. ASTM D659 - Evaluating Degree of Resistance to Chalking of Exterior Paints.
- B. ASTM D2244 - Instrumental Evaluation of Color Differences of Opaque Materials.
- C. AISC - Specifications for Design, Fabrication and Erection of Structural Steel for Buildings.
- D. AISC - Code of Standard Practice for Steel Buildings and Bridges.
- E. AISI - Light Gage Cold Formed Steel Design Manual.
- F. AWS D1.1 - Structural Welding Code.
- G. Metal Building Manufacturer's Association - Recommended Design Practices Manual.

## 1.06 DESIGN

- A. Manufacturer shall provide and be solely responsible for structural design of all members and their conditions. Execute design in accordance with applicable standards.
- B. A professional engineer registered in the State of            and qualified in structural design of buildings shall design and affix his seal to the shop drawings and calculations.
- C. Design Criteria shall be as indicated on structural drawings.
- E. Roofing and siding shall not be used as diaphragms.

## 1.07 GUARANTEES

- A. Replace or repair work which becomes defective or fails within the guarantee periods at no additional expense to the Owner. Guarantees to be furnished and signed by are presentative of the manufacturer who is authorized to; legally bind the manufacturer.
- B. Overall guarantee: Provide a guarantee warranting all materials and workmanship against defects for a period of one year.
- C. Roof system weather-tightness warranty: Provide a guarantee warranting roof panels and metal skylight curb materials against rupture, structural failure or perforation due to atmospheric corrosion for a period of twenty years.
- D. Finish guarantee: Provide a guarantee warranting the paint film finish for a period of twenty years.

## PART 2 PRODUCTS

### 2.01 FRAMING

- A. Eave height: 28'-0" minimum.
- B. Roof slope: 1:12.
- C. Primary framing: Columns and beams shall be complete with all required splice members and plates for bolted field assembly. Frames shall be designed for expansion as indicated on the Drawings.

D Anchor bolts will be furnished and installed by the General Contractor.

E Secondary framing:

1. Purlins, and girts: Live load deflection of purlins and girts shall not exceed  $L/240$ .
2. Bracing: Furnish flange braces, sag angles, threaded sag rods, etc., of cold- formed steel. Diagonal bracing shall consist of rods or rolled shapes. Cables shall not be used.
3. Framed openings: Provide structural framing members for all exterior openings of galvanized steel.

## 2.02 ROOF AND WALL COVERING

- A. Roof system: Provide manufacturer's standard 24 gage mechanically seamed standing seam roof panels of steel coated with Galvalume, both sides. Provide purlin spacing required for specific design loads. Live load deflection of roof panels shall not exceed  $L/80$ .
- B. Insulation: Roof insulation shall be 6 "R-19 and wall insulation shall be 4"R-13 by Manville, Owens-Coming, CertainTeed MBI202 or approved equal vinyl faced fiber glass blankets.
- C. Vapor retarder: Vapor retarder shall be 0.0032" minimum thick vinyl (perm rating 1.0 or less).
- D. Wall panels: Provide manufacturer's standard 24 gage wall panels of galvanized steel with standard fluoropolymer coating, color selected.

## 2.03 ACCESSORIES

- A. Gutters and downspouts: Provide gutters with expansion joints as required. Fabricate from minimum 24 gage steel. Size gutters and downspouts for run-off from 50-year storm.
- B. Roof openings: 14 gage single-piece, seamed-in curbs matching roof panel configurations, size to fit units.
- C. Roof hatch: Manufacturer's standard 30" x 36", 18 gage curb, with aluminum lid. Units to be factory assembled.

- D. Not Used
- E. Pipe flashing: Manufacturer's standard EPDM units.
- F. Fasteners: Manufacturer's standard 3/8" Torx head Scrubolt fasteners with 3/4" metal backed neoprene washers, 3/8" Torx head self-drilling screws with ALZN steel backed neoprene washers, or 3/4" self-clinching Lock-Rivet fasteners with neoprene washers.
- G. Sealant and tape: Type recommended by the manufacturer.
- H. Metal flashing, closures and trim: As required for weather-tightness and finish appearance. Where flashing is used in conjunction with other construction, provide approved fasteners for attachment. Finish shall match wall panels, color selected.
- I. Flashing cement FS SS-C-153.

#### 2.04 FINISH

- A. Preparation: Prepare all structural members by removing all dirt, grease, oil and loose mill scale. Clean as recommended by shop primer manufacturer.
- B. Shop primer. Manufacturer's standard applied in accordance with manufacturer's specifications.

### **PART 3 EXECUTION**

#### 3.01 ERECTION

- A. Structural framing shall be erected in accordance with approved Shop Drawings and MBMA "Recommended Design Practices", Part IV.
- B. Make all primary field connections with high strength bolts. Secondary connections may be machine bolted.
- C. Erect roofing and siding sheets in accordance with approved Shop Drawings and manufacturer's requirements. All panels shall be sealed with neoprene closures.
- D. Nestable panels shall be prepunched and fastened to structural members with Torx head Scrubolt fasteners, Torx head self-drilling screws or Lock-Rivet fasteners. All side laps shall be at least one full corrugation and end laps shall be 6" over structural members. All exposed fasteners shall be either prepainted to match siding or shall be covered with plastic color caps to match siding. All side and end laps shall be sealed with weather sealing compound.

- E. Panel to panel connections shall be made with Lock-Rivet fasteners. Lock-Rivets shall be set with special tool.
- F. After erection, touch up all marred, scratched or otherwise defaced finishes with matching finish or paint. Any surfaces repaired but not acceptable to the Architect, shall be replaced without additional cost to the Owner.

END OF SECTION

PART 1 –GENERAL

1.01 DESCRIPTION

- A. Work included: Provide a personal computer based supervisory control and data acquisition system (SCADA) complete with appurtenant equipment and accessories as indicated, specified, and as necessary for a complete and proper operating system. This work includes, but is not necessarily limited to, the following:
1. Supply and configure all personal computer hardware, control items, and instrumentation as indicated, specified, and required by the loop descriptions, Piping and Instrument Diagram, and other specifications sections contained herein.
  2. Supply and configure human-machine interface (HMI) applications software including the development of fully rendered 3D graphics displays, report ,trend displays, alarming, and other required functionality as defined herein or by Owner or by Engineer.
  3. Select all required system components and perform the final detailed engineering design, hardware and software installation, and onsite supervision necessary.
  4. Perform terminations of AC power and signal wiring associated with the control system.
  5. Perform off-site and on-site testing, operational demonstrations, and training as specified.
  6. Prepare operation and maintenance manuals and record drawings.
  7. Provide onsite comprehensive service and maintenance to extend for the duration of the one year warranty period.
  8. Submit the name and address of the nearest instrumentation and control system service provider who will perform service and maintenance for this system during the one year warranty period.

- B. The SCADA system shall be supplied as specified herein to monitor and control the Water Treatment Plant and future new Raw Water Intake. This SCADA system shall incorporate the existing SCADA system distribution system tank and booster station control and monitoring to allow the operation of the high service pumps at the water treatment plant as well as monitor and control the remote tank and booster pump station sites.
- C. Software applications development labor shall be supplied for complete configuration of a human-machine interface (HMI) package including graphics screens to run on two PC based HMI's. The Instrumentation and Control System Integrator shall be responsible for performing all HMI applications software development, development of historical reports, development of specialized PLC programming, startup and commissioning of the system, and providing training as required by these specifications.
- D. Installation Services - It shall be the responsibility of the instrumentation and control system integrator to provide the following installation services:
  - 1. Physically install the computer system hardware and all associated cabling.
  - 2. Power and signal conduit and wire shall be supplied and installed by the general contractor.
- E Related work:
  - 1. Documents affecting work of this Section include, but are not necessarily limited to, General Specifications, Special Provisions, and all other related Sections.

## 1.02 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by basic designation only.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ANSI/ASME B16.1      Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125,  
250, and 800



NATIONAL FIRE PROTECTION AGENCY (NFPA)

ANSI/NFPA 70          National Electric Code

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA ICS1              General Standards for Industrial Control and Systems

NEMA ICS 2            Standards for Industrial Control Devices, Controllers,  
and Assemblies

NEMA ICS 4            Terminal Blocks for Industrial Use

NEMA ICS 6            Enclosures for Industrial Controls and Systems

1.03    DEFINITIONS

- A.    SCADA System -Supervisory Control and Data Acquisition System
- B.    PC -Personal Computer System
- C.    PLC -Programmable Logic Controllers
- D.    I/O -Input/Output
- E.    HMI -Human-Machine Interface.

1.04    INSTRUMENTATION AND CONTROL SYSTEM INTEGRATOR QUALIFICATIONS

The Instrumentation and Control System Integrator Shall at minimum have the following qualifications:

- A.    Bonding capacity in January of 2018 of at least \$100,0000 for a single project.
- B.    Minimum of five years recent, Past experience (water/wastewater) in the design, construction, installation and successful startup of PLC-based PCS and SCADA systems of comparable size, type, and complexity to the proposed projects.
- C.    The System Integrator shall be Certified Wonderware System Integrator.

**1.05 TECHNICAL SERVICES:**

- A. The Instrumentation and Control System Integrator shall provide the following services during the course of this project:
1. Provide all project management and system design services required to insure a successful and fully functional SCADA system which meets the intended system functionality as described herein.
  2. Prepare and submit detailed shop drawings as submittals for approval.
  3. Develop and fully annotate all PLC programming.
  4. Develop and fully document all applications software.
  5. Provide the onsite services of a factory trained field service engineer to startup, calibrate, and place into service all Computer Hardware, instrumentation, Communication equipment, PLC-based Control Panels, and other ancillary devices and equipment as required to achieve a fully operational and functional system.
  6. Provide the onsite services of a factory trained software engineer to startup the system and to work with the factory trained field service engineer to rigorously test the entire system. Results of all testing shall be documented in writing on a site by site basis.
  7. Provide the onsite services of a factory trained field service engineer to perform training of personnel in the area of troubleshooting the specific equipment supplied.
  8. Provide the onsite services of a factory trained software engineer to perform training of personnel in the area of the human-machine-interface (HMI) applications software as applied specifically to this system.
  9. Provide the onsite services of a factory trained field service engineer and factory trained software engineer to make repairs to the system during the one year warranty period.

**1.06 TECHNICAL SERVICES:**

- A. Provide supervisory service of a factory trained service engineer, specifically trained on the type of equipment herein specified, for a period of not less than three (3) 8- hour days during construction to assist the Contractor in the location of mounting brackets, methods of installing conduit and special cable, mounting, piping, and wiring of one of each type of service, and the methods of protecting all of the equipment prior to placing it into service.

- B. Upon completion of equipment installation, provide services of the above service engineer for a period of not less than five (5) 8-hour days for calibration and start-up of the equipment and instructing the operating personnel.
- C. The minimum days specified above do not relieve the Instrumentation and Control System Integrator of providing sufficient service to place the system in satisfactory operation.

**1.07 SUBMITTALS**

- A. Comply with other pertinent provisions of this specification.
- B. Product data: Within 120 calendar days after the Contractor has received the Owner's Notice to Proceed, submit:
  - 1. Component manufacturing data sheet indicating pertinent data and identifying each component by item number and nomenclature as indicated on the drawings and in the specifications.
  - 2. Component drawing showing dimensions, mounting and external connection details.
  - 3. System wiring schematics, each on a single drawing with full description of operation. Component identification on the schematic shall be as indicated above.
  - 4. A system schematic of the hardware with the component manufacturing datasheets for each item, including all system peripherals.
  - 5. A printed copy of each control and monitoring screen and each regulator report form. A complete description of each screen shall accompany the print.
- C. Provide Operation and Maintenance manuals.
  - 1. Operating instructions shall incorporate a functional description of the entire system, including the system schematics which reflect "as-built" modifications.
  - 2. Special maintenance requirements particular to the system shall be clearly defined along with special calibration and test procedures.
  - 3. As part of the operation and maintenance manuals, provide three hardcopies of the program used to program the programmable logic controller.
- D. Purchase any and all software packages required for the system in the name of the City of Greenup. All warranties associated with the hardware and software shall be in the name of the City of Greenup.
- E. Provide to Engineer for approval any changes, additions, corrections, etc. required to the Bid Documents that are needed to accommodate the system being proposed. The changes, additions, corrections, etc. shall be at the Contractor's expense and shall be included in his Bid.

**1.04 COORDINATION OF WORK**

- A. Coordinate work of this Section with work of other sections.
- B. The Instrumentation and Control System Integrator shall be responsible for reviewing the contract documents that could affect this portion of the work.
- C. Plans and specifications, especially instrumentation/electrical and wiring requirements, have been formulated in an attempt to satisfy the conditions for the system proposed. However, a vendor may find that some changes or additional conduit and wiring from that indicated may be required to accommodate particular equipment being proposed. Should this be the case, the vendor shall include in his bid price, all changes or additional requirements necessary for the system. After award of contract, revised drawings must be submitted for approval indicating any changes prior to any changes being implemented.

**1.05 PRODUCT DELIVERY, HANDLING AND STORAGE**

- A. Schedule the delivery of the equipment to coordinate with the project completion schedule.
- B. Contractor's attention is directed to the fact that equipment has delicate components and extreme care shall be taken in handling to avoid internal and/or external damages.
- C. Damaged equipment will not be accepted.
- D. Equipment not for immediate use shall be stored inside a building, with enclosures under protective coverings and shall be fully protected from moisture, extreme heat and vibration.

**1.06 WARRANTY**

- A. Systems supplier shall furnish a hardware and software maintenance contract for the computer system, providing for a 24-hour response time in normal working hours, five days per week for the length of the One, (1), year warranty period, from written acceptance.
  - 1. For any service visit during this period, provide the Owner and Engineer with a written report stating the reason for equipment failure and recommendations to prevent recurrence.
- B. At the end of this period, the maintenance contract shall be made available for transfer to the Owner.

**PART 2 PRODUCTS**

**2.01 GENERAL**

- A The total control and monitoring system shall consist of a series of individual control and monitoring sub-systems, each configured to perform a specific function associated with the total plant operational scheme.
- B All equipment and materials shall be new, unused and proved by previous use of similar products to be completely suitable for the service intended.
- C All of the equipment shall be the manufacturer's latest and proven design. Specifications and drawings call attention to certain features but do not purport to cover all details entering into the design of the SCADA system. The completed system shall be compatible with the functions required and other equipment furnished by the Contractor.
- D All electrical components of the system shall be powered by 120V, single phase 60 cycle current, except as otherwise indicated or specified.
- E All contacts for control, remote motor operated, or electrically operated equipment shall be rated not less than 10 amperes on 120V unless otherwise specified herein.
- F All systems and individual components, whether panel or field mounted units, shall be protected from voltage and/or current surges which may originate as a result of lightning or other external causes.
  - 1. Protective equipment to be provided by the SCADA System supplier and installed in accordance with his recommendations.
  - 2. Schematics of the instruments submitted for approval to the Engineer shall indicate how this protection will be provided and identify the items of equipment which shall be used for this purpose.
- G. System manufacturer to supply "as-built" drawings containing all necessary information for proper maintenance and operation of the system.
  - 1. Wire log table showing connections (wire terminations) between all furnished components to be supplied to facilitate field wiring.
  - 2. Interconnection information between system components and equipment found in other sections of these Specifications shall be complete with all necessary interconnection information.
  - 3. Notes which refer to equipment manufacturer's drawings for proper interconnection will not be acceptable.
  - 4. Provide within 30 days after startup and after any field modifications.

**2.02 PLANT SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEMA.**

**A System Description and System Components**

1. The overall plant Supervisory Control and Data Acquisition (SCADA) System shall include, as a minimum, the following:
  - a. Three, (3), Operator Workstations
  - b. One, (1), Ethernet-resident PLC-based Control Panels
    1. Central Control Panel -Main Electrical Room
  - c. One (1), Remote 900 mhz Ethernet Radio linked PLC
    1. Future Raw Water Intake
  - d. Three, (3), Ethernet-resident Vendor Supplied PLC Panels
    1. Acticarb Control Panel
    2. Filter System Control Panel
2. The personal computer system running the HMI software package shall communicate with the PLCs using an Ethernet data highway. The systems integrator shall be responsible for building graphics and developing PLC control logic for the new plant as well as incorporating graphics and controls for the existing plant into the new HMI applications software.

**B. Personal Computer Systems**

1. Provide a Personal Computer-based supervisory control and data acquisition (SCADA) system. Design the system to provide overall monitoring of plant operations, alarm/event logging, report preparation, historical data storage and process control functions as detailed in the operations descriptions.

The Computer hardware package shall include the following devices:

- a. Personal Computer System Hardware;
- b. Uninterruptible Power Supply (UPS) System;
- c. Operating System and Office Applications.
- e. Ethernet Hub/Switches

- 2 Three, (3), Operators Workstations shall be provided. The Operators workstation shall also function in a fully redundant mode. The operator Workstations shall, at a minimum, be comprised of the following:

- Dell Precision 7920 Towers
- [Dual Intel Xeon Gold 6134 3.2GHz, 3.7GHz Turbo, 8C, 10.4GT/s 3UPI, 24.75M Cache, HT \(130W\) DDR4-2666](#)
- [NVIDIA® Quadro® P1000, 4GB, 4 mDP \(7X20T\)](#)
- 32GB RAM (DUAL Processor Compatible)
- [MegaRAID SAS 9440-8i 12Gb/s PCIe SATA/SAS controller - SW RAID 0, 1,5,10](#)
- [2.5" 1TB 7200rpm SATA Hard Drive](#) – (2 Hard Drives)
- [2.5" 512GB SATA Class 20 Solid State Drive](#) (1)
- [8x Half-Height BD-RE Drive Cables](#) Cyberlink PowerDVD™
- Integrated Sound Blaster Compatible
- Dell USB Keyboard
- Dell Optical Mouse USB
- 1BG NIC CARD
- Dell UltraSharp 29 Wide Monitor U2917W
- Resource DVD
- Recovery Disk
- Dell AS501 Sound Bar for all UltraSharp Flat Panel Displays
- Year On-site Business Standard Plan
- USB TAPI Modem
- APC Smart-UPS 1500VA 120V
- Dell 2.0 stereo speaker system and Dell sound bar for select flat-panel displays

- 3 The Following Software shall be supplied on each Operator Workstation

- Windows® 10 Professional Version License with media
- Microsoft® Office Latest Professional Edition Full License with media
- Adobe Acrobat Pro 2017 Full License with media
- Norton Security Premium, Latest Version (2 year)

4. Tablet PC

A Tablet PC shall be provided to function as an Operator Workstation. The Tablet PC shall be supplied complete with Docking Station, External Display, Keyboard and Mouse. The Tablet PC shall at minimum meet the following specifications:

- Lenovo Thinkpad X1 Tablet 3G

- Processor : Intel Core i7-7Y75 Processor (4MB Cache, up to 3.60 GHz)
- Operating System : Windows 10 Pro 64
- Operating System Language : Windows 10 Pro 64 English
- Display : 12.0 FHD+ (2160 x 1440) IPS Touch
- Memory : 16GB LPDDR3 SDRAM 1866 MB
- Body Color : Black
- Thinkpad Pen : ThinkPad Pen Pro
- Security Features : Integrated Fingerprint Reader
- Security Chip : Hardware dTPM
- TPM Setting : Hardware dTPM2.0 Enabled
- Hard Drive : 512 GB Solid State Drive, PCIe-NVMe OPAL2.0
- Battery : 2 Cell Li-Cylinder Battery 37WH
- Power Cord : 45W AC Adapter (2pin) - US (USB Type C)
- Wireless : Intel Wireless-AC 8265 2x2 AC, Bluetooth 4.1 vPro
- vPro Certified Model : vPro Certified
- Motherboard : Intel Core i7-7Y75 Processor (4MB Cache, up to 3.60 GHz), 16GB LPDDR3 1866MHz on board
- Base : 12.0" FHD+ (2160x1440), WiFi & Bluetooth 4.1, FPR
- Keyboard : Thin Keyboard-Midnight Black US English
- Language Pack : Publication - EnglishPackaging : Standard Retail Packaging
- Warranty : 1 Year Depot or Carry-in

**6 Report Writer & Color Printer**

- a. Provide one HP OfficeJet Pro 7740 Wide Format AiO color ink jet printer for use as both a report writer and as a color printer/copier.
- b. Provide three boxes of high quality ink jet paper (500 sheets per box) (8.5x11) and two boxes of. high quality ink jet paper (500 sheets per box) (11x17)
- c. Provide 3 spare cartridges of each cartridge.

**7 Laser Printer**

- a. A Color LaserJet Professional CP5225n Printer The Laser Printer shall be 1200 dpi and support the following media sizes:
- b. Provide three boxes of High Quality Laser Paper (500 Sheets per box).
- c. Provide one spare Toner Cartridge each.



**8. Uninterruptible Power Supply (UPS) System**

- a. For each computer system provide one (1) Uninterruptible Power Supply (UPS) System to provide transient protection and backup AC power. The UPS system shall provide true online power protection to prevent any break in power. The UPS system shall provide continuous, clean sine wave power for a period of at least 15 minutes after loss of commercial power. The unit shall also provide brownout protection to boost sags in AC power.
- b. The UPS system shall be UL 1449 listed for surge protection with a mean time between failure of at least 100,000 hours. The unit shall have passed ANSI/IEEE C62.41 Categories A and B. RF noise isolation shall be accomplished using a full-time advanced multi-stage filter. Noise (RF) Isolation shall not exceed 60 dB common-mode or 80 dB normal-mode.
- c. The UPS shall be sized for a minimum capacity of 1400 VA.

**9. Interconnecting Cables**

- a. The Instrumentation and Control System Integrator shall furnish all specialty cables required for interconnections between the computer system and all peripherals.

**1.01 PLC COMMUNICATION DATA HIGHWAY**

Communications between the computer system running the HMI software and the various programmable logic controllers (PLCs) located around the plant shall utilize an Ethernet Cat-5 data highway. The General Contractor shall install the communication cable supplied by the system integrator. All Ethernet Cat-5 terminations shall be the responsibility of the instrumentation and control systems integrator. The fiber Optic Cable shall be supplied under separate contract.

**1.02 FAST ETHERNET SWITCH/HUB**

- A. Ethernet Switch will be IEEE802.3 compliant. The Switch will be provided with 2ea.10/100/1000 Base FX, Fiber Optic Single-Mode, full duplex port with SC Connectors. The Ethernet switch shall support a fault tolerant self-

healing ring configurations. The unit shall also be supplied with five, (5), 10/100/1000 Base TX, RJ45 connector ports for local network connection. The Ethernet switch can be cascaded from any port over any number of switches. With the auto-negotiation function, each individual port will set automatically to 10Base-T or 100Base-TX or 1000 Base-TX and to either full or half-duplex connection. The switch will be capable of signaling loss of a port connection by providing a dry contact closure for alarming purposes.

- B. Ethernet Switch will accept two independent 24vdc power inputs, and will be capable of automatically switching from primary to secondary power inputs in the event of loss of supply to the primary power input without loss of operation. The switch will be capable of signaling loss of either power input by providing an alarm relay output for alarming purposes.
- C. The Switch shall provide improved utilization of bandwidth and automatic regulation of the network load. The switch shall support the forming of Virtual user groups (VLANs as per IEEE 802.1 Q) and multicasts limited to specific destinations. Logging onto a multicast group shall be performed using IGMP snooping. In this way, all users shall receive the appropriate information at the same time. Also, using the flow control and port priority functions, network overload can be prevented and time- critical data reliably and quickly passed to the related recipient without additional software.
- D. The industrial switch shall be supplied with network management and analysis software suite developed specifically for the industrial controls. The interface software shall seamlessly integrate monitoring and analyzing of Ethernet networks into the leading human-machine interface (HMI) software packages. Display screens shall be created to provide the SCADA operators with a real-time view of the health of their Ethernet network devices, the overall Ethernet network traffic volume and overall Ethernet network status from within their HMI software environment.
- E. Ethernet Switch will be capable of 0-60 degree Celsius operating temperature. Ethernet Switch will be DIN rail mountable.
- F. Switches shall be Hirschmann RS2-FX/FX Rail Switch, Modicon 499NOS17100 ConneXium Switch, or approved equivalent.

The Fiber Optic Transceivers shall be supplied at the following Locations

- 1. Central Control Panel

#### 1.03 Networking Switch & VPN Router

A 10/100/1000 16-port VPN Router shall be supplied for remote access to the Water Treatment Plant. The VPN router shall communicate to a DSL or Cable broadband modem supplied by the owner.

## 2.08 HUMAN-MACHINE INTERFACE (HMI) APPLICATIONS DEVELOPMENT

- A. All PLC controller programming and Human Machine Interface (HMI) and Operator Interface Panel (OIP) graphics and programming shall be done by the System Integrator. This programming shall include, but not be limited to, input/output (I/O) mapping, graphic screens, alarms, etc. The supervisory control and data acquisition (SCADA) system shall utilize an off-the-shelf, industry standard human-machine-interface (HMI) software product that includes support for process supervisory control, data acquisition, alarming, historical data collection and trending, and management report generation along with other third party software products such as I/O servers, spreadsheets, databases, etc., The HMI applications software package shall be configured by the System Integrator specifically for this system.

As a minimum, the following graphics shall be required:

1. Overview of Water Treatment Plant.
2. One Display Screen for Process Area Including summary screens for the Filter Control System, Acticarb Clarification System, Disinfection and any other Vendor supplied Control Panels
3. One Display for the Raw Water Intake
4. One Display for the Distribution SCADA System
5. Process Control Screen for each Process Subsystem, Including control tuning screens for automatic backwash, plant start-up and plant shutdown.
6. Individual Control Pop-Up for each Pump, motor, or device requiring SCADA Control. Real Time Trend Screens for each process analog signal.
- 7 Real Time Trend Screens for each process analog signal.
- 8 A "System Overview" screen
- 9 Utilities screen for system functions such as tape backup, access to windows file explorer, security configuration etc.
- 10 Menu system to allow easy movement between the various graphic displays.

- 11      An “Alarm Screen” which shows all signals which are presently in alarm and the status of each (i.e. “Acknowledged” or “Unacknowledged”).
- B      The System Integrator is responsible for providing all programming and configuration services and ancillary equipment to accomplish the control and monitoring functions as described in the contract specifications and drawings. The System Integrator shall provide all programming functions including but not limited to control strategies and communications. The ISS shall also provide all programming and configuration services necessary to produce the operator interface (graphic displays, trends, historical archive, etc.) as described in the contract specifications and drawings. Configuration shall include interfacing field devices and equipment provided under this subcontract with new Operators Workstations and PLC equipment
- C      The System Integrator shall develop and provide all graphic screens for the systems provided. The graphics shall be designed and function with the Human Machine Interface (HMI) software. The exact number and type of customized process graphic screens shall be determined at the coordination meeting(s). The graphic displays to be developed shall represent the process equipment and instruments provided under this subcontract, as specified herein and as shown on the Drawings. Screen prints shall be submitted to the owner for approval

## **2.09 HMI SOFTWARE GRAPHICS CAPABILITIES**

- A.      The human-machine interface (HMI) applications software package shall be Wonderware’s Intouch version 10.0 or approved equal. Provide all required I/O servers and other ancillary software programs shall be supplied as required to form a complete and fully functional SCADA system.
- B.      Applications Development
1.      It is recognized that the specified HMI packages does not inherently contain the functionality required to form a complete supervisory control and data acquisition (SCADA) system. It shall be the responsibility of the System Integrator to develop the required functionality of a SCADA system by using the tools provided by the HMI package in conjunction with the tools provided in other specified software such as Microsoft’s Excel spreadsheet, Microsoft’s Access database, and Microsoft’s “Word” word processor, etc.
  2.      The developed functionality shall include but not be limited to:
    - a.      Database entry and all system configurations required for a complete, proper, and operating, monitoring and control system, including control strategy configuration where applicable.

- b. Formatting regular shift, daily, monthly and annual operating performance reports required for system operation.
- c. Configuring a minimum of 25 process graphic and/or group displays in order to provide the necessary operator interface to the system.
- d. Configuring a special multi-page monthly report designed to present monthly operating data in the general format as required by state regulatory agencies.

**3 HMI Application Software Manual**

- a. Provide complete documentation for operation and maintenance, covering operating system software and application software as developed specifically for this project.
- b. Furnish two (2) sets of documentation for the Microsoft Windows^ operating system software.
  - 1. This to be Microsoft's standard comprehensive documentation for the specific version of the operating system as Supplied for this project.
  - 2. Include complete user setup and configuration information for proper utilization of the system.
- c. Furnish two (2) sets of detailed User's Guides for the Wonderware InTouch software product. These manuals are to be original User's Guide documents as provided by Wonderware. Xeroxed copies of such manuals are not acceptable.
- d. Furnish two (2) sets of detailed Applications Software Manual as developed by the System Integrator.
  - 1. Design manuals to permit Owner's personnel to adequately understand the operation of the system as it relates to the process being controlled.
  - 2. Sub-divide manuals into detailed sections describing each of the major software sub-systems provided.
  - 3. Each sub-section to include an overview or abstract defining in general terms the function of that particular sub-system.
  - 4. Following the overview include a detailed functional description of the operation of that particular sub-system.

- a. Include detailed explanation of all operator inputs required.
  - b. Include copies of typical displays involved with the function of the particular sub-system.
  - c. Where applicable, include copies of typical hardcopy printouts associated with the sub-system.
  - d. Make significant use of step-by-step examples to simplify system use and operation.
  - e. All user manuals are to be sturdily bound in hardback binders or in original bindings as furnished by the supplier.
- C. The System shall support multiple display types including lists, graphics, trends, etc. The System Integrator shall provide all HMI Screens necessary for the efficient operation of the system and process as follows.
- D. Display Call-up: Display presentation shall provide the following features:
  - 1. All graphic displays which contain a device in-alarm shall show its symbol flashing to allow immediate recognition of the problem by the operator and minimize operator error.
  - 2. Bargraphs shall indicate the alarm limits and, if applicable, the setpoint for the value. The current value shall also be shown along with its data quality.
- E. Process graphics. Graphics capability shall include conditional color (ie, where the color of a symbol or value is dependent upon some condition), and dynamic graphics (i.e. vary symbol presentation based upon it's analog value). A hierarchical structure for the displays with a maximum of four levels should be employed. See section 13305 1.07.F.5-8 for display
- F. The Color Code for equipment status is the following:
  - On - Red - Open
  - Off- Green. - Close
  - Trouble - Yellow - Fail
- G. Tabular Displays. All tabular displays shall be capable of being printed on the report printer. This shall normally be manually initiated, but provision shall be made for automatic printing periodically if desired. The following tabular displays shall be provided:

1. Alarm Summary. This display shall summarize all current alarms. The display shall be generated from stored data on disk, and shall consist of the point identification number, point name, time of occurrence, status (high, low, failure, normal, etc.), and time of return to normal if applicable. This, and all other alarm tabular displays shall present alarms from the latest to the oldest ordered by:
    - a. Unacknowledged critical alarms
    - b. Unacknowledged non-critical alarms
    - c. Acknowledged critical alarms
    - d. Acknowledged non-critical alarms
  2. Current Alarm Summary. This display shall list all points currently in alarm. The display shall be generated on-line from stored data on disk, and shall consist of all points currently in alarm with point identification number, point name, time of occurrence, and type of alarm. |
  3. Point Status Summary. This display shall show the status of all points in the system, including both real and calculated points. Information provided shall consist of the point Identification number, point name, and its current status (i.e., Running, Off, High, Low, Active, Disabled, ON-scan, OFF-scan, value, etc.).
- H Data Editing displays. Displays shall be provided through which the operator can interactively control the operation of the control system. Displays shall be provided which:
1. Allow the operator to define the destination of a report or printout (e.g., Display, printer, computer file, etc.) and when it is to be printed (e.g. immediately, on demand, or automatically at a certain time).
- I Trend control. The operator shall be able to define additional trends of any variable in the system database (real-time trending) or in the historical database (historical trending) as follows:
1. Trend displays shall present the operator with multiple options (e.g., with or without limits, time scale).
  2. A cursor line or point shall be provided which can be moved along the curve to obtain exact readings at any point. |
  3. It shall be possible to overlay different trend curves to facilitate the comparison of related parameters.
  4. It shall be possible to trend up to four different parameters on the same scale, each parameter being represented by a different color.
- J Reports. The final format of all reports shall be developed by the System Integrator, Design Engineers and Owner following Contract Award. All reports shall be capable of automatic and on-demand printing. All reports shall be archived for future use.

1. Operational Reports shall be provided for the plant. They shall show the start count and runtime of all equipment, and all analog process values such as level, pressure, and other analytical Instruments. The following types of reports shall be provided with the system:
2. Daily reports shall show hourly values grouped according to some common trait. Chemical usage, flows, runtimes, etc. shall be displayed, with the maximum, minimum and average or total (as appropriate) for the day summarized at the bottom.
3. Monthly reports shall provide information in a similar format to the daily reports, and the monthly report data shall be derived from the same values used by the daily reports. The average or total shall be shown by date. Monthly reports shall accommodate for leap year and other date discrepancies. At the bottom of each column, the minimum, the maximum and the average or sum (as appropriate, pH is averaged, flow is totaled) for that column shall be calculated. The top of the report shall include Time, Date, Plant Location, Area identifier, Report title, etc.
4. Monthly and Yearly Regulatory Reports: The state and the EPA will require some documents on a monthly and yearly basis. It shall be the System Integrators obligation to confer with the Design Team to determine and to implement the proper report generation of these documents.

**K. Automatic Dialing and Voice Annunciation Alarm Management System**

1. The Automatic Dialing and Voice Annunciation Alarm Management System shall consist of Microsoft Windows based software compatible with Win10, capable of accomplishing the following tasks:
2. Upon alarm events: facilitate the display, sorting, and filtering (e.g. by date and time range) of alarm information to the screen of a Windows based computer system.
3. Upon alarm events: facilitate the compilation and transmission of alarm information via SMTP as HTML or plain text email (POP3/IMAP inbound). TLS/SSL is supported.
4. Upon alarm events: facilitate the compilation and transmission of alarm information to mobile devices as SMS via SMTP (carrier gateway required).
5. Upon alarm events: facilitate the compilation and transmission of alarm information to mobile devices as SMS/EMS/MMS (CDMA/GSM/HSPA/LTE cellular modem required).



6. Upon alarm events: facilitate the compilation and transmission of alarm information over POTS (TAPI Voice Modem required) and VOIP (SIP Server required) lines to residential or commercial sites or mobile phones.
7. Upon alarm events: facilitate the compilation and transmission of alarm information via IP to mobile and tablet devices companion App.
8. Following notification: provides for acknowledgement of alarms over all above communication modalities, secured with password/numeric code authentication. Such acknowledgements shall pass identifying information regarding the actor to the SCADA where possible, including the actor's ack comments where possible.
9. Allows for unsolicited Alarm Requests over all above communication modalities.
10. Allows for unsolicited Report (current process variable values and alarm states) Requests over all above communication modalities.
11. The notification software allows for software licensing
12. The notification software communicates natively with Wonderware InTouch, Wonderware System Platform, GE iFIX, GE CIMPLICITY, and Rockwell Automation FactoryTalk View A&E Servers or in a generic manner via OPC DA Classic 2.0 to other applications.
13. The notification software supports filter-based subscriptions to alarms from Wonderware InTouch, Wonderware System Platform, GE iFIX, GE CIMPLICITY, and Rockwell Automation FactoryTalk View A&E, eliminating the need for tag imports and resulting maintenance of redundant configuration.
14. The notification software may be used in Hot Backup or Redundant SCADA applications. The SCADA software can put the notification software in "Standby" or "Active" mode through script.
15. The notification software supports the creation of "Watchdog Alarms" for monitoring the status of SCADA/HMI connectivity.
16. The notification software shall support connection schedules, including schedules with arbitrary recurrence e.g. "6 days on, 4 days off".
17. The notification software shall allow for monitored alarmable objects to be grouped, including non-hierarchical groupings.
18. The notification software shall associate each monitored alarmable object with a notification strategy allowing for:

- The notification of individual connections
  - The pushing of reports (process variable values and alarm states) to individual connections
  - The notification of dynamically composed sets of connections
  - The pushing of reports to dynamically composed sets of connections
  - The automatic acknowledgement of alarms
  - Arbitrary delays for escalation.
19. The notification software shall allow the actions of a notification strategy to be executed a configurable number of times and/or with a configurable frequency. Further, such actions shall also support conditional execution based on the state of the alarm, priority of the alarm event, and/or date/time of occurrence of the event (e.g. for adapting to scheduled maintenance).
  20. The notification software shall allow for the assignment of a “Do Not Notify” strategy during maintenance downtime thus eliminating unnecessary or undesired notification attempts.
  21. The notification software shall log alarm state changes and strategy actions, including notification attempts, notification results, acknowledgement attempts, and acknowledgement results.
  22. The notification software shall provide a browser based configuration utility accessible across the network and supporting multiple languages and cultures including Chinese, English, French, German, Hebrew, Italian, and Spanish.
  23. Telephony shall support Text To Speech for supported languages and cultures.
  24. The Alarm System shall be Win911 Professional or equal.

L. Data Modem

A data modem shall be furnished with the Alarm System software and used for transmissions of Voice, E-Mail or Alphanumeric Pager messages. It is recommended that the modem should be capable, at minimum, of communications at 300, 1200 and 2400 BAUD and should handle both the Bell212A and v.22 communications standards. Data Modem may: be internal or external to computer system.

## 2.10 HMI SOFTWARE

The human-machine interface (HMI) applications software package shall be InTouch by Wondeware. The System Integrator shall provide all required I/O servers and other ancillary software programs shall be supplied as required to form a complete and fully functional SCADA system. The following HMI software packages are required:

Item	Qty	Description
1.	1	Workstation #1 - (latest Version at time of purchase) 3000 Tag Development Package
2.	1	Workstation #2 - (latest Version at time of purchase) 3000 Tag Runtime Package
3.	1	Workstation #3 - (latest Version at time of purchase) 3000 Tag Runtime Package
4.	1	Tablet PC - Workstation #4 - (latest Version at time of purchase) 3000 Tag Runtime Package
5.	1	WIN-911/TEP-Bundle - for Alarm Notification, Voice Auto Dialer
6.	1	Team Viewer - Remote Access Software (Two year Subscription)

#### 2.11 PLC-BASED I/O SUBSYSTEM ENCLOSURES

- A It is the intent of this specification to establish minimum requirements for a solid-state programmable logic controller designed to provide high reliability for this application.

The internal wiring of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory.

The controller shall be supplied with the CPU, input/output scanner, inputs, outputs, memory, power supply, and all power and interface cables necessary to function as a complete and operable programmable controller system.

**B PLC Hardware**

The new In-Plant PLCs shall be manufactured by Allen Bradley. The Programmable Logic Controllers supplied shall at minimum the meet the following specifications:

**Allen Bradley Controllogix's Hardware**

Qty	Description	Model Number
1	PLC Processor	1756-L71
1	Ethernet/IP Module	1756-ENBT
4	16 Pt Discrete Input Module	1756-IB32
2	16 Pt Discrete Output Module	1756-OB32
5	8 Pt Analog Input Module - 16pt differential	1756-IF16
3	8 Pt. Analog Output Module	1756-OF8
1	Prosoft Ethernet I/P to Serial Converter	MVI56E-MCMR
1*	Evoqua LC3000 Intralink PLC	W3T269792

\*Note: The PLC noted shall be furnished, installed and programmed, connected to the specified VHF FCC licensed radio modem and HMI PC to provide control and monitoring to existing tank and booster pump/valve remote transceiver units (RTU's) in the existing Greenup Water Distribution System

**C PLC Locations**

Programmable logic controllers (PLCs) shall be supplied for the following locations:

1. CCP - Central Control Panel
  - a. A new Nema 12 PLC based Control Panel shall be supplied and installed at the location detailed on the drawings. An Allen Bradley ControlLogix PLC with Ethernet Communications adapter, power supply, and I/O shall be supplied.
  - b. Minimum wired I/O complement shall be as detailed in the I/O Table listing:
  - c. The Central Control Panel shall be provided with a VHF serial radio compatible to the City's existing distribution radio telemetry system to communicate to the existing Remote Tank and Booster Pump/Valve locations.
  - d. The CCP shall be provided with a wireless 900 mhz 1 watt Ethernet radio to communicate to the Raw Water Intake PLC Control Panel.
2. Raw Water Intake RTU

- a. PLC control equipment shall be furnished and installed under separate contract for this location.
- b. The Raw Water Intake PLC Control Panel shall communicate to the treatment plant via wireless Ethernet communications.

**D Cabinets and enclosures:**

1. Provide cabinets with hinged doors and lift-off panels for easy access.
2. Cooling fans and inlet louvers with replaceable filters shall be used to provide proper cooling.
3. Enclosures for PLC-based I/O sub-systems which shall be mounted in hostile environments or outdoors shall be of NEMA 4X construction (304 stainless steel).
4. Enclosures for PLC-based I/O sub-systems which shall be mounted in non-hostile indoors environments shall be of NEMA 4 construction (painted carbon steel), free-standing with 8" floor supports, approx. 36"W x 72"H x 12"D.
5. Cooling equipment shall be sized to maintain the proper temperature inside the enclosure with outside ambient temperature at 90 Deg F.1

**E. PLC Enclosure Construction**

1. All PLC equipment shall be suitable for operation 120V, 60 Hz, single phase power.
2. Receptacles with isolated ground shall be supplied for computer devices in the control room and internal to the PLC enclosures.
3. All field wiring terminations shall be made to terminal strips capable of accommodating up to #12 AWG wire. Terminal strips shall be mounted using DIN rails. Terminal strips shall be as manufactured by Phoenix, Square D, or approved equal.
4. All analog inputs, including spare analog inputs, shall be protected from surges using three separate levels of surge/transient suppression. The first level of protection shall be via a 1/4 Amp 3AG size fast acting fuse. Secondary and tertiary protection shall be fulfilled using combination gas discharge and metallic oxide varistor (MOV) surge protection with current limiting resistors. Terminals shall be installed to allow each of the four analog inputs to be configured for 2-wire or 4-wire process transmitters and to produce either 4 to 20 mA or I to 5VDC outputs to the PLC and any future display or signal conversion devices .Terminals shall be installed adjacent to the analog surge protection to provide 24 VDC for connections of future 2-wire transmitters.

5. All digital inputs, including spare digital inputs, shall be isolated from field wiring through terminal strips and mechanical relays. Minimum contact rating for relays shall be 5 Amps at 250 VAC.
6. All digital outputs, including spare digital outputs, shall be isolated from field wiring through terminal strips and electro-mechanical relays with contact ratings of 10 Amps at 250 VAC minimum.
7. Separate DC power supplies shall be provided for the PLC and for field analog and digital inputs. All DC power supplies shall be protected via indicating 3AG size fast acting fuses, indicating fuse holders shall be DIN rail mounted.
8. A fluorescent light (18" minimum) shall be mounted in the top of each PLC enclosure. The light shall be wired to a 2 pole limit switch which shall be mounted on the door of the PLC enclosure. When the door is opened, the light will automatically be turned on. When the door is closed, the light will automatically be turned off. Also as the door is opened the second pole of the limit switch shall be wired to a non-relay-isolated input of the PLC to provide an intrusion signal to the computer system.
9. Surge protectors shall be provided internal to the PLC enclosure to provide transient and surge protection from the phone line.
10. A Best Fortress LI-1020U (1020 KVA) Uninterruptible Power Supply shall be provided integral to each PLC enclosure.
11. Two (2) circuit breakers shall be provided integral to the PLC. One circuit breaker shall provide protection to the PLC's internal power supplies and the other circuit breaker shall provide protection to a Ground Fault Interrupt (GFI) duplex utility outlet.
12. A Square D AC power surge protector shall be installed integral to the PLC to provide transient and surge protection for incoming AC power. A separate GFI duplex utility outlet shall be protected by the surge protector and shall be used only for the UPS system.

## **2.12 MODIFICATIONS TO EXISTING REMOTE TELEMETRY UNITS**

- A. The existing Greenup Water Distribution SCADA/Telemetry system shall remain in operation during construction, and prior to startup of the new CCP panel at the new water treatment plant, shall be modified as follows:
  1. Each RTU shall be retrofitted with updated radio modems, furnished, programmed and installed by the systems integrator, to operate with the City's existing remote PLC panels and existing/new water plant PLC.

2. The radio modems shall be Calamp Guardian 100 VHF Serial Radio Modems, P/N 140-5016-500. The radio modems shall include a 2 ft. RG400 coax jumper cable with TNC male connection on one end and N male connection on the other.
3. A new Remote Transceiver Unit (RTU) shall be furnished and installed by the systems integrator for the “Greenbo Booster Pump / Master Meter” location in the booster station building. The RTU shall consist of enclosure, power supply, surge arrestor, VHF radio modem, antenna, PLC, Ethernet switch, and Scadаметrics Ethermeter with radio filter for reading the master meter register and transmitting the reading to the water plant HMI PC. The RTU panel shall be identical to the existing Greenup distribution system booster pump station RTU panels and fully programmed to operate with the existing system.

## **2.13 RADIO COMMUNICATIONS SUBSYSTEM**

### **A. Communications Hardware; General Requirements**

1. Integrated wireless modem hardware that complies with applicable FCC or NTIA requirements for refarming shall be supplied. The radio and the modem must be packaged together and internally interfaced with each other.
2. On-line, non-intrusive RF network diagnostic monitoring shall be provided as a standard feature in the system architecture.
3. Wireless modem hardware of a ‘packetized’ design may not be used. Units shall be data transparent to allow for a minimum amount of data transmission latency and to limit data transmission overhead, thus allowing the wireless modem to obtain the data rates specified.
4. Keying of wireless modem hardware may be accomplished by either RTS signaling or data activated transmit. Data can be presented to wireless modem hardware for transmission when the Data Activated Transmit or DOX mode is selected.
5. The wireless modem hardware must be protocol transparent and independent. It must support 7 or 8 data bits, 1 or 2 stop bits, even, odd, or no parity.

### **B Remote Station Wireless Modem**

1. The remote station wireless modems shall operate within the 132 to 174 MHz frequency band.

2. The remote station wireless modem shall have authorization of notification or type- acceptance for legal operation in a 6.25 and/or 12.5 kHz bandwidth channel, including 4800 or 9600 bps operation at 6.25 or 12.5 kHz. The unit shall be operated at either 4800 bps or 9600 bps in a 12.5 kHz channel, but must be capable of operation at a speed of at least 9600 bps.
3. The unit shall operate in the half-duplex mode with the base wireless modem transmitter.
4. In the RTS Mode, assertion of RTS by the remote terminal unit shall initiate the data transmitting sequence. The remote wireless modem unit will provide a CTS signal to the remote terminal unit, indicating readiness to begin sending data over the air.
5. In the DOX Mode, the presence of data will activate the transmitter and begin sending data over the air without the need of RTS handshaking from the remote terminal unit.
6. The remote station wireless modems shall be Calamp Guardian 100 VHF Serial radio modems, compatible to the existing Greenup distribution system radio modems.

C. Directional Antennas for Water Treatment Plant Radio Modems

The VHF Distribution Radio Modem Omni Antenna must meet the following requirements:

Frequency Range	Appropriate to frequency of operation
Gain	2.5 dB, minimum
Maximum Power Input	500 watts
SWR	Less than 1.5:1
Lightning Protection	Direct ground protection to mast
Front-to-Back Ratio	20 dB, minimum
Connector	Type N, female
Mounting Hardware	Weatherproof clamp suitable for direct mount to 2 inch, Schedule 40 steel pipe

Provide Telewave Model ANT150F2 or equal.



The 900 mhz Yagi Antenna for the Raw Water wireless Ethernet communication must meet the following requirements:

Frequency Range	Appropriate to frequency of operation
Gain	13.1 dBi, minimum
Maximum Power Input	150 watts
SWR	Less than 1.5:1
Lightning Protection	Direct ground protection to mast
Front-to-Back Ratio	20 dB, minimum
Connector	Type N, female
Mounting Hardware	Weatherproof clamp suitable for direct mount to 1-1/4 inch, Schedule 40 steel pipe

Provide PCTel Maxrad Model MYA93012 or equal.

**E Transmission Cable & Miscellaneous For Remote Station Radio**

Provide cable connecting the radio antenna port to the antenna, which is LMR400 coaxial cable. Provide standard Type N connectors for connection to a continuous piece of cable extending to the antenna.

**2.14 RTU ENCLOSURES**

All RTU components shall be housed in a single padlockable enclosure suitable for wall or floor mounting as shown on the contract drawings.

1. All enclosures shall be constructed to meet or exceed the NEMA 4X or Nema 12 depending on where the unit is to be installed. Access doors shall have continuous stainless steel hinges and approved latching. Provide internal bracing as required for rigidity. Heat load calculations shall be performed by the System Integrator to insure that the enclosure is properly sized to allow adequate; cooling.
2. All enclosures which are to be installed outdoors shall be provided with top, front, and side solar shields. Solar shields are to be constructed of aluminum and shall be painted white. The top solar shield shall overhang the side solar shields. Solar shields shall be mounted to enclosures using minimum 1-1/2" standoffs.
3. A heater and thermostat shall be supplied inside the RTU enclosure to prevent the condensation of water.

4. Anti-corrosion inhibitor blocks shall be mounted inside each RTU enclosure to reduce corrosion. Corrosion inhibitors shall be Hoffman Model A-HCI10E or equal as approved by the engineer.
5. RTU enclosures shall be rated as follows:
 

RTU-Outdoors	NEMA 4X, Fiberglass, with Solar Shields
RTU-InDoors	NEMA 12 Carbon Steel

#### 2.15 INPUT/OUTPUT (I/O) REQUIREMENTS

- A Provide I/O as detailed in I/O table listing
- B All analog inputs, including spare analog inputs, shall be protected from surges using three stage surge/transient suppression devices. The first level of protection shall be via a 1/4 Amp 3AG size fast acting fuse. Secondary and tertiary protection shall be fulfilled using a combination of three terminal gas discharge tube and metallic oxide varistor (MOV) surge protection with current limiting resistors. Terminals shall be installed adjacent to the analog surge protection devices to provide convenient access to 24 VDC for connections of future 2-wire transmitters. Additional terminals or jumpers shall be installed to allow each of the four analog inputs to be configured to produce one 4 to 20 mA or 1 to 5 VDC signal to the PLC plus one auxiliary output signal connected to terminals to drive an additional or future digital display or signal conversion device.
- C All digital inputs, including spare digital inputs, shall be isolated via electro-mechanical relays. Minimum contact rating for relays shall be 10 Amps at 250 VAC. Digital inputs isolation relays shall be connected to field wiring via DIN rail mounted terminal strips. A 2 Amp 3AG size fuse installed in an indicating fuse holder shall protect the 24 VDC power supply for all digital inputs. A minimum of twelve (12) relays shall be provided and shall be fully wired to twelve (12) of the sixteen (16) available digital inputs. Additional digital inputs shall be wired via interposing relays if required to accommodate additional digital field input signals.
- D One Digital Input shall be dedicated to monitor AC power failure for the RTU.
- E A Digital Input shall be dedicated to monitor Low Battery power condition of the uninterruptible power supply (UPS) system.
- F A Digital Input shall be dedicated to monitor the limit switch mounted on the door of the RTU enclosure.
- G Digital outputs shall be isolated from field wiring through terminal strips and electro-mechanical relays with minimum contact ratings of 10 Amps at 250 VAC. A minimum of six (6) relays shall be provided and shall be fully wired to six (6) of the available digital outputs. Additional outputs shall be wired via interposing relays if required to accommodate additional digital field output signals.

## 2.16 INPUT/OUTPUT TABLES (HARDWIRED)

LOCATION – WATER PLANT CCP PANEL

<u>I/O DESCRIPTION</u>	<u>I/O TYPE</u>	<u>I/O SOURCE</u>
High Service Pump #1 Run	DI-0	New VFD Output Relay
High Service Pump #2 Run	DI-1	New VFD Output Relay
Power Fail	DI-2	Battery Charging Relay
Caustic Pump #1 Run	DI-3	Metering Pump
Caustic Pump #2 Run	DI-4	Metering Pump
Caustic Pump #3 Run	DI-5	Metering Pump
Caustic Pump #4 Run	DI-6	Metering Pump
Caustic Pump #5 Run	DI-7	Metering Pump
Caustic Pump #1 Fail	DI-8	Metering Pump
Caustic Pump #2 Fail	DI-9	Metering Pump
Caustic Pump #3 Fail	DI-10	Metering Pump
Caustic Pump #4 Fail	DI-11	Metering Pump
Caustic Pump #5 Fail	DI-12	Metering Pump
Caustic Pump #1 in Auto	DI-13	Metering Pump
Caustic Pump #2 in Auto	DI-14	Metering Pump
Caustic Pump #3 in Auto	DI-15	Metering Pump
Caustic Pump #4 in Auto	DI-16	Metering Pump
Caustic Pump #5 in Auto	DI-17	Metering Pump
Fluoride Pump #1 Run	DI-18	Metering Pump
Fluoride Pump #2 Run	DI-19	Metering Pump
Fluoride Pump #1 Fail	DI-20	Metering Pump
Fluoride Pump #2 Fail	DI-21	Metering Pump
Fluoride Pump #1 in Auto	DI-22	Metering Pump
Fluoride Pump #2 in Auto	DI-23	Metering Pump
Sodium Hypo Pump #1 Run	DI-24	Metering Pump
Sodium Hypo Pump #2 Run	DI-25	Metering Pump
Sodium Hypo Pump #3 Run	DI-26	Metering Pump
Sodium Hypo Pump #1 Fail	DI-27	Metering Pump
Sodium Hypo Pump #2 Fail	DI-28	Metering Pump
Sodium Hypo Pump #3 Fail	DI-29	Metering Pump
Sodium Hypo Pump #1 in Auto	DI-30	Metering Pump
Sodium Hypo Pump #2 in Auto	DI-31	Metering Pump
Sodium Hypo Pump #3 in Auto	DI-32	Metering Pump
Phosphate Pump #1 Run	DI-33	Metering Pump
Phosphate Pump #2 Run	DI-34	Metering Pump
Phosphate Pump #1 Fail	DI-35	Metering Pump
Phosphate Pump #2 Fail	DI-36	Metering Pump

Phosphate Pump #1 in Auto	DI-37	Metering Pump
Phosphate Pump #2 in Auto	DI-38	Metering Pump
HS Pump VFD #1 Fault	DI-39	VFD Output Relay
HS Pump VFD #2 Fault	DI-40	VFD Output Relay
Plant Door Intrusion (N/C)	DI-41	Door Switches in Series
Low UPS Battery Alarm	DI-42	UPS
Carbon Feed Common Alarm	DI-43	Carbon Controller
Carbon Feed Running	DI-44	Carbon Controller
Carbon Powder Low Alarm	DI-45	Carbon Controller
Spares	DI-46 thru 64	Spares wired to terminals
Raw Water Flow (gpm)	AI-0	New mag meter
Plant Effluent Flow (gpm)	AI-1	New mag meter
Clearwell Level (ft)	AI-2	New submersible level transmitter
Caustic Pump #1 Feed Rate Feedback (FB)	AI-3	Metering Pump
Caustic Pump #2 Feed Rate FB	AI-4	Metering Pump
Caustic Pump #3 Feed Rate FB	AI-5	Metering Pump
Caustic Pump #4 Feed Rate FB	AI-6	Metering Pump
Caustic Pump #5 Feed Rate FB	AI-7	Metering Pump
Fluoride Pump #1 Feed Rate FB	AI-8	Metering Pump
Fluoride Pump #2 Feed Rate FB	AI-9	Metering Pump
Sodium Hypo Pump #1 Feed Rate FB	AI-10	Metering Pump
Sodium Hypo Pump #2 Feed Rate FB	AI-11	Metering Pump
Sodium Hypo Pump #3 Feed Rate FB	AI-12	Metering Pump
Phosphate Pump #1 Feed Rate FB	AI-13	Metering Pump
Phosphate Pump #2 Feed Rate FB	AI-14	Metering Pump
Caustic Tank Scale (lbs.)	AI-15	Drum Scale
Filter Aid Tank Scale (lbs.)	AI-16	Drum Scale
Phosphate Tank Scale (lbs.)	AI-17	Drum Scale
Fluoride Tank Scale (lbs.)	AI-18	Drum Scale
Ferric Tank Scale (lbs.)	AI-19	Drum Scale
Sodium Hypo Tank Scale (lbs.)	AI-20	Drum Scale
Finished Water Chlorine Residual (ppm)	AI-21	Chlorine Residual Analyzer
Finished Water Fluoride Level (ppm)	AI-22	Fluoride Analyzer
Finished Water pH Level	AI-23	pH Analyzer
Finished Water Turbidity (NTU)	AI-24	Turbidimeter
High Service VFD #1 Current (amps)	AI-25	HS Pump VFD
High Service VFD #2 Current (amps)	AI-26	HS Pump VFD
Ferric Bulk Tank Level (ft.)	AI-27	Ultrasonic Level Transmitter
Caustic Bulk Tank Level (ft.)	AI-28	Ultrasonic Level Transmitter
Sodium Hypo #1 Bulk Tank Level (ft.)	AI-29	Ultrasonic Level Transmitter
Sodium Hypo #2 Bulk Tank Level (ft.)	AI-30	Ultrasonic Level Transmitter
Spares	AI-31 thru 40	Spares wired to terminals

Caustic Pump #1 Feed Rate Command	AO-1	PLC Analog Output to Metering Pump
Caustic Pump #2 Feed Rate Command	AO-2	PLC Analog Output to Metering Pump
Caustic Pump #3 Feed Rate Command	AO-3	PLC Analog Output to Metering Pump
Caustic Pump #4 Feed Rate Command	AO-4	PLC Analog Output to Metering Pump
Caustic Pump #5 Feed Rate Command	AO-5	PLC Analog Output to Metering Pump
Fluoride Pump #1 Feed Rate Command	AO-6	PLC Analog Output to Metering Pump
Fluoride Pump #2 Feed Rate Command	AO-7	PLC Analog Output to Metering Pump
Sod. Hypo Pump #1 Feed Rate Command	AO-8	PLC Analog Output to Metering Pump
Sod. Hypo Pump #2 Feed Rate Command	AO-9	PLC Analog Output to Metering Pump
Sod. Hypo Pump #3 Feed Rate Command	AO-10	PLC Analog Output to Metering Pump
Phosphate Pump #1 Feed Rate Command	AO-11	PLC Analog Output to Metering Pump
Phosphate Pump #2 Feed Rate Command	AO-12	PLC Analog Output to Metering Pump
High Service Pump #1 Speed Command	AO-13	PLC Analog Output to VFD
High Service Pump #2 Speed Command	AO-14	PLC Analog Output to VFD
Carbon Feed Rate Adjustment	AO-15	PLC Analog Output to Carbon Feeder
Spares	AO-16 thru 24	Spares wired to terminals
HS Pump #1 Start	DO-1	RTU Output relay
HS Pump #2 Start	DO-2	RTU Output relay
Caustic Pump #1 Start	DO-3	RTU Output relay
Caustic Pump #2 Start	DO-4	RTU Output relay
Caustic Pump #3 Start	DO-5	RTU Output relay
Caustic Pump #4 Start	DO-6	RTU Output relay
Caustic Pump #5 Start	DO-7	RTU Output relay
Fluoride Pump #1 Start	DO-8	RTU Output relay
Fluoride Pump #2 Start	DO-9	RTU Output relay
Sodium Hypo Pump #1 Start	DO-10	RTU Output relay
Sodium Hypo Pump #2 Start	DO-11	RTU Output relay
Sodium Hypo Pump #3 Start	DO-12	RTU Output relay
Phosphate Pump #1 Start	DO-13	RTU Output relay
Phosphate Pump #2 Start	DO-14	RTU Output relay
Carbon Feeder Start	DO-15	RTU Output relay
WTP Common Alarm	DO-16	RTU Output relay to annunciator
Generator Run	DO-17	RTU Output (HS Pump Lockout)
Spares	DO-18 thru 32	Spares wired to terminals
Generator Status and Alarms	SER-1	RS232 Connection to Generator

(Note: I/O type designations: AI = analog input, AO = analog output, DI = digital input, DO = digital output, TCP/IP = Network Connection, SER = Serial Network Connection)

2.17 RADIO FREQUENCY COORDINATION AND LICENSING

The System Integrator shall be responsible for modifying the City of Greenup's existing FCC license for Distribution System telemetry reflecting changes to the existing system outlined herein.

PART 3 – EXECUTION

3.01 SURFACE CONDITIONS

- A Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.02 INSTALLATION

- A Coordinate as required with other trades to assure proper and adequate provision in the work of those trades for interface with the work of this Section.
- B Install the work of this Section in strict accordance with the original design and the manufacturer's recommended installation procedures as approved by the Engineer, anchoring all components firmly into position for long life under hard use.
- C Perform all wiring.
  - 1. Final connections and/or terminations for all 120 volt and higher power wiring indicated on the electrical drawings and in this division of the specifications shall be made by the electrical contractor unless otherwise noted. Final connections and/or terminations for all signal, data and low voltage control wiring indicated on the electrical drawings and in this division of the specifications (shielded cable, fiber optic cable and #14 AWG wiring) shall be made by the appropriate system or equipment vendor or integrator unless noted otherwise. Equipment supplied under other divisions of the specifications that require electrical connections under this division shall be provided with Engineer approved wiring and termination diagrams.

3.03 APPLICATIONS SOFTWARE DEVELOPMENT

- A The Wonderware shall be developed to include new 3-D Graphics for the WTP. Man-Machine Interface (MMI) software as specified shall be supplied and fully configured by the instrumentation and control system vendor. Reports, graphics displays, real-time trends, historical trends, security, and alarming shall be developed by the instrumentation and control system vendor through a collaborative effort between the Engineer, Owner, and instrumentation and

control system vendor. Graphics displays shall be designed by the instrumentation and control system vendor for each major process area of the plant and for each remotely monitored site. Graphics displays shall be fully colorized representations of the various plant facilities and shall be based upon plan and elevation representations of the facilities taken from AutoCad drawings provided by the Owner/Engineer.

B In general, the operator interface to the system shall be via a hierarchy of graphics screens with “poke points” which will allow operators to navigate the plant facility by facility by simply “clicking” on the poke points with a mouse pointing device.

1. A "Main Menu" shall be developed and will contain "poke points" to allow navigation to the following major subsystems:
  - a. WTP overview displays.
  - b. Process Sub-System Displays.
  - c. Real-time trend displays.
  - d. Historical trend displays.
  - e. Excel reporting subsystem.
  - f. I/O diagnostics test displays.
  - g. Current alarms.
  - h. Equipment maintenance subsystem.
2. The “Main Menu” shall contain dynamic symbols to depict the operational/communications status of each PLC on the network (i.e. PLC Normal or PLC in Communications Failure).
3. Each graphic display shall be designed so that an operator may “click” on “poke points” to gain access to any area of the plant, to the water distribution system, or to the Main Menu. The operator shall also be able to access the Current Alarms Display from any graphic display. Real-time and Historical Trend displays shall be made available from each plant process area via poke points.
4. All graphics displays of plant areas shall utilize AutoCad drawings as a basis for the display. All displays shall be drawn to scale to represent actual site conditions and actual equipment and facility colors when possible. It is the intent of this specification that all graphics displays which depict plant facilities shall appear to an operator exactly as the actual facility appears in elevation view. The instrumentation and control system vendor is strongly encouraged to utilize AutoCad drawings of each facility for development of graphics displays. AutoCad drawings of plant and distribution system facilities shall be furnished to the instrumentation and control system vendor by the Owner or Engineer.
5. Special graphics displays shall be developed by the instrumentation and control system vendor for each process control strategy. These graphics displays shall allow authorized operators to modify control parameters such as set points, operational sequences, etc.

Passwords shall be utilized to determine the authorization level of operators.

6. All process alarms shall be categorized by “group” with each group representing a specific area of the plant or distribution system.
7. Security of the system shall be accomplished via allowing access to various parts and features of the system via entry of User names and passwords.
8. Graphics screens shall be developed for each major item of process equipment for which equipment runtime or equipment maintenance data is being collected. These graphics screens shall contain all data relative to the piece of equipment including runtime today, runtime since last serviced, total runtime between maintenance intervals. All runtime data shall be maintained by the various programmable logic controllers; not by the MHI software package.
9. All historical process data, such as average flows, hourly minimums and maximums, etc., shall be maintained by the various programmable logic controllers; not by the MMI software package.

**3.04 GRAPHIC DISPLAY DESIGN MEETING AND SUBMITTALS**

- A. A One, (1), day graphic display design meeting shall be held with the Engineer and Owner’s personnel to discuss specific details of overall design of the graphic displays including discussions of the particular signals which are to be displayed on each graphic display.
- B. Prior to the meeting the instrumentation and control system vendor shall submit detailed sketches of the proposed graphics displays to the Engineer for review.
- C. The meeting will take place at the WTP or the design Engineers Office.

**3.05 PROCESS CONTROL STRATEGY DESIGN MEETING AND SUBMITTALS**

- A. A One, (1), day process control strategy design meeting shall be held with the Engineer and Owner’s personnel to discuss specific details of the control strategies which are to be developed for the system.
- B. Prior to the meeting the instrumentation and control system vendor shall submit a detailed narrative for each of the proposed control strategies to the Engineer for review.
- C. The meeting will take place at the WTP or the design Engineers Office.

**3.06 REPORT DESIGN MEETING**

- A. A One-Half, (1/2) day report strategy design meeting shall be held with the Engineer and Owner’s personnel to discuss specific details of the various



historical data reports and state reports which are to be developed for the system.

- B. The meeting will take place at the WTP or the design Engineers Office.

**3.07 PROJECT PLANNING AND SPECIFICATION DEVELOPMENT MEETING**

- A. A One, (1), day Project Planning and Specification Development meeting shall be held with the Engineer and Owners personnel to discuss specific details of the for the final design.

- B. The meeting will take place at the WTP or the design Engineers Office.

**3.07 TRAINING**

- A. System supplier to provide operation and maintenance training for Owner's personnel to ensure their adequate knowledge of use of the system.

- B. Training to be conducted on-site by instructors thoroughly familiar with operation of the system, with training divided into three general areas as follows:

- 1. Analog and digital hardware maintenance training:

- a. Instruct Owner's maintenance personnel in the proper preventative maintenance and repair tasks associated with system maintenance.
- b. For analog instrumentation, include detailed instruction of calibration and checking along with familiarization training for basic repair and maintenance tasks that are expected to be encountered.
- c. For computer hardware maintenance, include general familiarization with computer hardware and peripheral devices with instruction in preventative maintenance tasks associated primarily with peripheral devices. It is not intended that this course will produce trained computer maintenance technicians.
- d. Include detailed instruction in maintenance and repair work associated with the computer process I/O sub-system.
- e. Minimum training time for this material to be sixteen (16) hours.

- 2. Operator familiarization training:

- a. Instruct Owner's operating personnel in the proper use of the analog and digital process control system.
- b. Include instruction in the system control steps and basic interface with the computer system.
- c. Provide sufficient training to Owner's operating personnel so they can respond to the normal tasks required for operation of the plant.

- d. Minimum training time for this material to be eight (8) hours.
- 3. Supervisor and application software training:
  - a. Provide supervisory personnel with a working knowledge of all application software supplied.
  - b. Include basic digital and computer concepts, process control concepts, database configuration, report configuration, graphic display configuration, and control strategy development.
  - c. Minimum training time for this material to be sixteen (16) hours.
- 4. Follow-up Training:
  - a. Approximately 60 days after system start-up follow-up training shall be provided.
  - b. The training shall answer any questions on the day to day use of the system.
  - c. Minimum training time for this material to be sixteen (16) hours.

**3.08 START-UP SERVICE**

- A. Upon final completion of all components determine date of start-up jointly with Engineer, Owner and Contractor.
- B. System supplier to be responsible for placing of SCADA equipment and systems in operation.
- C. System supplier to provide qualified personnel on the job site until successful operation of system is attained.

**END OF SECTION**

## **1. GENERAL**

### **1.1 Description**

#### **1.1.1 Related work specified elsewhere**

1. Electrical (Division 16)
2. Mechanical (Division 15)
3. Section 11320 and Section 11602

#### **1.1.2 Description of System**

Provide and install a complete and operable instrumentation and control system, which includes instruments, wiring, and all interfacing. System as specified herein describes basic intent and general design.

The Instrumentation and Controls specified in this section include equipment and quantities that are not included as part of the packages specified in Section 11320 Activated Carbon Treatment and Section 11602 Filtration Equipment. References are made to these equipment package sections to assure that the instrumentation specified in this section and in the referenced treatment sections are furnished from the same manufacturer and are duplicated to provide the owner with continuity of operation and maintenance of this instrumentation.

The intent of this specification is to require that the complete instrumentation, control and monitoring system, including all primary elements, panel mounted and miscellaneous field instruments, etc., shall be furnished by a single Instrumentation, Control & Monitoring (ICM) supplier to assure system reliability, uniformity, compatibility and coordination of all system interfaces.

The ICM supplier shall furnish all tools, equipment, materials and supplies and perform all labor required to complete the furnishing and installing, including all validation, start-up and operational testing of the complete and operable instrumentation, control and monitoring system as indicated on the drawings and as specified herein. The ICM supplier shall provide formal instruction during start-up to the Owner's personnel so that the personnel are able to operate the equipment in an effective manner. Training aids and manufacturer's literature shall be provided for all components of the system.

The supplier shall, following final installation and acceptance of the equipment on the job site, provide quarterly adjustment and inspection of the equipment for a period of twelve months following the date of acceptance without additional charge to the Owner.

**1.2 Quality Assurance**

Except as otherwise specified, the ICM system described herein shall be as supplied by the C. I. Thornburg Co., Inc. of Huntington, WV (304-523-3484) or an approved equal. All suppliers of similar equipment bidding to these specifications shall furnish to the A/E within seven (7) days prior to the bid, a pre-bid submittal package which shall, as a minimum, include:

- a. Specifications on every instrument to be used in this section. Information shall define mechanical dimensions and electrical details.
- b. System sketches of the instrumented process shall be supplied giving details of the proposed equipment, functions, and interfaces.
- c. A written description of functionality of the proposed control system with respect to these specifications.
- d. Complete installation list reflecting a minimum of five (5) years of as a system supplier of similar or identical equipment.
- e. Location of nearest factory trained service representative and stocking warehouse for renewal parts purposes.
- f. Quality assurance program in the manufacturing and testing of the equipment to be furnished.

Failure to include all of the required information in its entirety may be considered non-responsive and due cause for rejection of alternate equipment. The Owner and the A/E reserve the right to waive any informality in the submittal requirements.

The A/E shall be the sole judge as to the similarity and acceptability of the alternate equipment.

**1.3 Instrumentation, Controls, & Monitoring Subcontractor**

The ICM Subcontractor shall be a systems supplier regularly engaged in similar applications and have at least five (5) years of successful experience in supplying integrated instrumentation and control systems.

The system supplier may also be required to demonstrate his capabilities by defining his resources to successfully prosecute the work as called for in these specifications. Resources shall be defined as capital facilities, personnel, plant, and services.

The system supplier shall also have in his employ the personnel required to configure and support the software required for this application. The service organization shall be located within 100 miles of the job site. In addition to the above, the ICM supplier shall maintain service repair facility with fully trained personnel. The facility shall have all the necessary calibration and testing equipment to perform any repairs after manufacturer warranties have expired. This service center should have a dedicated area exclusively for repair and related services.

- 1.4 Contractor - The Contractor, as distinguished from the ICM Subcontractor, shall provide all additional materials and work necessary to supplement the materials and work provided by the ICM Subcontractor and shall satisfy all requirements that are within the scope of this section.

No form of energy shall be turned on to any part of the instrumentation system prior to receipt by the A/E of a certified statement of approval/authorization - from the ICM Subcontractor for turning on energy to the system.

- 1.5 Related Work Not Included in this Section

Process piping, installation of items in process pipelines, air compressors, and miscellaneous mechanical work as specified in other Divisions. Electrical power distribution specifically included under circuit protection devices, multiconductor signal conduit, cable, miscellaneous electrical requirements, motor control centers, etc.

The A/E views the following items as possible areas where interpretation may be determined to be vague by the General Contractor, his electrical subcontractor (if any) and the ICM supplier. This list is meant to clarify misunderstandings on the items listed:

- A. Electrical Contractor shall provide and install:
- Instrumentation and control wiring and mark terminal connections.
  - Instrumentation and control conduit.
- B. General Contractor to install:

- Valves
- Flowmeters
- All instrumentation supplied with mechanical equipment.
- All on-line connections, process pipe taps, cast or cut holes in concrete, etc.
- Air piping, if applicable.

#### **1.6 System Responsibilities**

The Contractor's attention is directed to the fact that the ICM system as specified in this Section is an integrated system and therefore shall be provided by a single competent, qualified instrumentation supplier (ICM Supplier) who shall have total responsibility for the work of this system.

Prior to the execution of any Agreement between the Owner and the successful Bidder for this project, the following certification shall be signed, notarized and provided to the Owner and A/E for review and concurrence: "\_\_\_\_\_ (official name of ICM supplier) hereby certifies intent to assume and execute full responsibility, to select, to furnish; to supervise installation and connection, to test and calibrate, and to place into operation, all meters, instruments, alarm equipment, control panels, computer and other assemblies, components, and accessories needed to place into service complete operating process control systems, all in full compliance with the requirements of the ICM Specifications.

In addition, it is certified that drawings and data will be prepared and submitted, specified field services will be performed by qualified personnel, operating personnel will be instructed, and technical manuals will be prepared and submitted, all as required by the ICM Specifications.

It is also certified that the quotation offered provides for full and complete compliance with the requirements of the ICM Specification without exception."

All electrical equipment and materials, including their installation, shall conform to Division 16 of these specifications unless specified otherwise in this Section.

#### **1.7 Submittals**

1.7.1 Manufacturers literature and shop drawings shall be submitted in strict accordance with Section 01305 - Equipment Submittals.

1.7.2 Operation and Maintenance Manuals - Prepare and submit to the A/E for checking and transmittal to Owner four (4) Operation and Maintenance Manuals. Each manual shall include the following:

- A. Equipment function, normal operating characteristics and limiting conditions.

- B. Assembly, installation, alignment, adjustment and checking instructions.
- C. Operating instructions for start-up, normal operation, regulation, shutdown and emergency conditions.
- D. Maintenance instructions.
- E. Guide to "Troubleshooting".
- F. Parts list.
- G. Outline and assembly drawings, engineering j data and wiring diagrams.

**1.8 Maintenance and Service**

1.8.1 General - Provide maintenance and call back (emergency) service as defined by the A/E for one (1) year following date of final acceptance of work at no additional cost to Owner. Maintenance shall be performed by competent personnel of the service organization and shall include necessary adjustments and/or calibrations, cleaning and replacement of parts. Owner shall be furnished with written report of each examination covering work performed and condition of system. Renewal or repair necessitated by misuse, negligence or other conditions beyond the manufacturer's or supplier's control are not included in maintenance.

**2. PRODUCTS**

**2.1 General**

A. The system shall provide all of the functions described and detailed in these specifications and on the drawings. Only major equipment items are specified; however, the ICM Subcontractor shall be responsible for providing all items of equipment that are necessary to provide proper system performance. ICM supplier shall provide necessary panels with wiring and terminal blocks ready for telemetry installation.

**B. Special Design Criteria**

All of the equipment shall be of the manufacturer's latest design. The completed system shall be compatible with the functions required and the equipment furnished by the Contractor.

All electrical components of the system shall be powered by 120 volt, single-phase, 60 cycle, except as may be otherwise noted in the specifications.

All remote motor operated or electrically operated equipment will have a separate 120 volt control circuit.

Information transmission shall be by means of 4-20 mA electronic signals.

All necessary fuses or switches required by the instrumentation manufacturer for his equipment shall be provided with the equipment. All instruments requiring an internal power supply shall have an internal ON-OFF switch.

All necessary DC energy sources shall be included.

**C. Flow Control**

The flow into and out of the water treatment plant will be established by the plant operator after consideration of the water levels in the distribution system storage tanks and in the plant clearwell. The discharge from the plant will be established manually or automatically by the SCADA system by choosing which high service pump or pumps shall operate. Complete sequential automatic operation of the entire plant and raw water pumping facility shall be possible by activation of the high service pumps.

Raw water flow from the raw water intake shall originate with the existing or future raw water pumps. The operation of the raw water pumps shall begin with the pumps, then after a slight delay, the vertical turbine pumps. This will ensure the clearwell for the vertical turbine pumps will have sufficient water supply. When the operator ceases operation of the raw water pumps, the operation shall be the same: the raw water pumps shall stop, then, after a slight delay, the high service pumps.

Raw water flow into the plant shall be controlled automatically or manually by adjusting the speed of the Raw Water Pump VFD's. When selector switch is in the "Manual" position, the speed of the raw water pumps shall be manually entered in the HMI PC. When the selector switch is in the "Automatic" position, the raw water flow shall be established by remote "Flow Control" setpoint inputs.

Change in modes of operation shall be switchable within the lab console without rewiring or PLC reconfiguration. The controller shall be overridden by the manual control.

The raw water flow and high service flows shall be indicated, recorded and totaled on the water treatment plant control computer. The clearwell level shall also be indicated and recorded on the water treatment plant control computer.



**D. Chemical Feed Control System**

The rate of chemical feed shall be established by manual adjustment of a rate setter on the chemical feeders and stroke adjustment on the chemical feed pumps. These feeders shall also be capable of being paced or capable of being modified so that they can be paced from the raw water or high service flow meters or from the streaming current monitor. All necessary current or signal boosters shall be furnished as required. These shall be mounted in the main control panel.

Input/Output requirements for the chemical feed equipment is shown in Section 13600. When the chemical feeder local selector switch is in the "Local" or "Manual" position, feed rate adjustment shall be accomplished locally on the chemical feed instrument. When the chemical feeder local selector is in the "Remote" or "Auto" position, feed rate adjustment shall be manually entered from the HMI PC or rate command from associated analyzers.

**E. Clarifier Operation (IDI Pulsator or Acticarb System)**

The clarifier operation will be per the manufacturer's control sequence. The ICM supplier shall obtain the information from the control panel of this equipment and display on the water treatment plant control computer.

**F. Filter Operation**

The filter operation will be per the filter manufacturer's control sequence. The ICM supplier shall supply filter level measurement equipment to perform the following functions:

1. Indicate individual filter levels.
2. High or low level filter alarm.
3. Initiate auto backwash sequence.

Filter mode of operation (manual, semi-auto, auto) as well as individual filter status will be indicated on the filter panel and display on the water treatment plant control computer.

**2.2 MAGNETIC FLOW METERS**

**2.2.1 Manufacturers:**

Danfoss.

Khrone.

Rosemount.

Or approved equal.

**2.2.2 General:**

The ISI shall furnish magnetic flow meters and all appurtenant work suitable for the service listed, at ambient temperatures, complete and operable, and capable of continuous operation with minimum error due to pipe deposits, in accordance with the requirements of the Contract Documents.

**2.2.3 Meters:**

The magnetic flowmeter shall utilize characterized electromagnetic induction to produce a voltage linearly proportional to the average flow rate. The metering system shall consist of a sensor with field coils, transmitter and interconnecting cables to make a complete operating flow metering system.

**2.2.4 Flow Tube:**

Shall be a dc powered, flanged magnetic flowmeter flowtube capable of monitoring liquids with a conductivity of 5 microsiemens/cm or greater. The flowtube shall have a Teflon lining and measuring electrodes shall be 316L. Grounding rings shall be provided if the tube is used with non-conductive piping. The flow shall be submersible to 30 feet of water (IP 68). Power to the flowtube is provided by the magnetic flowmeter transmitter only. Electrical connections to the flowtube shall be ¾ - 14NPT conduit threads. The flowtube shall be Rosemount model 8750WA or pre-approved equal.

**2.2.5 Grounding:**

Meters installed in non-conductive pipe or pipe lined with a non-conductive lining shall be furnished with one grounding ring of the same materials as the sensing electrodes.

**2.2.6 Transmitter:**

Shall be a remote-mounted four-wire microprocessor based dc magnetic flowmeter with HART digital communication protocol. Proprietary or single vendor protocols are not acceptable. The transmitter shall operate on 115V ac, 60 Hz. Electrical connections shall be ¾-14 NPT conduit threads. The flow transmitter and flow tube system accuracy shall be +/- 0.5 percent of flow rate from 1 to 30 feet per second. The transmitter shall provide two user selectable coil drive frequencies, digital signal processing capabilities for reducing process noise, and the ability to adjust transmitter response time.

The transmitter shall have an integral mounted LCD meter, which will display flow rate and totalized flow. The LCD meter shall have front panel keyboard that will allow for full communication to the transmitter.

**2.2.7 Installation:**

All magnetic flow meters and all appurtenant work shall be installed in strict accordance with the manufacturer's printed instructions. All meters shall be properly grounded to the adjacent pipe as specified, and located in such a way to assure a full pipe at all times.

Mag meters on this project include the "Raw Water Flow", "Finished Water Flow", and "Backwash Flow" as shown on the plans.

**2.3 SUBMERSIBLE LEVEL TRANSDUCERS**

- 2.3.1 The liquid level of the Clearwell is to be monitored and transmitted to the CCP shall be sensed by a Siemens Water Technologies Bulletin A1000i, Model 157GSCI Submersible Level Transducer. The Transducer shall be a two-wire type to operate from a supply voltage of 10.5 to 24 VDC from the CCP and produce a 4-20 ma DC instrumentation signal in direct proportion to the measured level excursion over a factory-calibrated range specified by the Engineer.
- 2.3.2 The transducer shall be of the solid-state head-pressure sensing type, suitable for continuous submergence and operation and shall be installed in accordance with manufacturer's instructions. The bottom diaphragm face of the sensor shall be installed 6 inches above the floor of each basin. The sensor shall be mounted using a stainless steel cable system in a location and as shown on the job plans. The transducer housing shall be fabricated of type 316 stainless steel with a bottom diaphragm 2-5/8" diameter of heavy-duty, limp, foul-free, molded Teflon (TM) bonded to a synthetic rubber back/seal.
- 2.3.3 A hydraulic fill liquid behind the diaphragm shall transmit the sensed pressure to a solid-state variable-capacitance transducer element to convert the sensed pressure to a corresponding electrical value. The sensed media shall exert its pressure against the diaphragm that flexes minutely so as to vary the proximity between an internal ceramic diaphragm and a ceramic substrate to vary the capacitance of an electrical field created between the two surfaces. A stable, hybrid, operational amplifier assembly shall be incorporated in the transducer to excite and demodulate the sensing mechanism. The transducer shall incorporate laser-trimmed, temperature compensated, high quality components and construction to provide a precise, reliable, stable output signal directly proportional to the sensed pressure over a factory-calibrated range.
- 2.3.4 The transducer element shall incorporate high over-pressure protection and be designed to withstand intermittent overpressures five times the full-scale range being sensed. Metallic diaphragms shall not be acceptable in that they are subject to damage or distortion. Sensing principles employing LVDTs, resistive or pneumatic elements shall not be acceptable.

- 2.3.5 The internal pressure of the lower transducer assembly shall be relieved to atmospheric pressure through a heavy-duty urethane jacketed hose/cable assembly and a slack PVC bellows mounted in a weatherproof, fiberglass upper assembly. The sealed breather system shall compensate for variations in barometric pressure and expansion and contraction of air due to temperature changes and altitude as well as prevent fouling from moisture and other corrosive elements.
- 2.3.6 The transducer assembly shall be installed where directed by the Engineer and connected with other system elements and placed in successful operation. It shall be provided with input power and output signal transient protection, associated control elements as specified herein and in accordance with manufacturer's instructions.
- 2.3.7 The sensor shall be suspension-mounted using a Siemens Water Technologies cable suspension mounting kit or equivalent, consisting of a 2' long 1-inch NPT type 316 stainless steel pipe with coupling, bolt, cable clamps and hardware along with the required length of 1/8 inch diameter 7 x 19 stainless steel cable.

#### 2.4 TURBIDIMETER / pH ANALZERS

- 2.4.1 Turbidity and pH monitoring equipment shall be furnished by the activated carbon treatment and filtration equipment manufacturers for the following locations and applications:

Raw Water Turbidity

Settled Water Turbidity (2 ea., one per train)

Filtered Turbidity (4 ea., one per filter)

Combined Filter Turbidity (1 ea. prior to Clearwell)

- 2.4.2 In addition, pH shall be monitored and connected to the turbidity controller at all of the above locations
- 2.4.3 Turbidity and pH monitoring equipment shall be furnished by the SCADA integrator or ICM for the following application. The sample point for each instrument shall be from the discharge of the High Service Pumps:
  - Plant Effluent Turbidity
  - Plant Effluent pH
- 2.4.4 Turbidity and pH monitoring instrumentation shall be identical to those specified for the "Raw Water" analysis in Section 11320.

#### 2.5 STREAMING CURRENT ANALYZER

- 2.5.1 The instrument shall be a streaming current monitor that continuously measures electrical charge in a water sample after the water has been dosed with coagulants which destabilize suspended colloids. The

instrument shall be capable of indicating on a digital meter the numerical charge value that corresponds to optimum coagulant dose.

- 2.5.2 For ease of integration, the system shall transmit three analog output signals (0 to 10 vdc, -10 to 10 vdc, and 4 to 20mA) that are proportional to the Streaming Current Value.
- 2.5.3 The system shall be calibrated at the factory for a +/-0.25% accuracy of reference readings. The system shall be two modules (sensor and monitor) capable of 5000 feet separation. Both modules require 110 VAC:
- 2.5.4 The sensor shall receive a sample at the rate of 5 gallons per minute to ensure sample line cleanliness and sensor cell reliability. The sensor shall have sample exit orifice larger than entrance orifice to avoid pressurizing the cell. The sensor response time shall not be greater than 2 seconds at recommended sample flow rate. Sample must enter cell from the side and exit at a 45 degrees downward angle to prevent accumulation of grit, sludge, sand, etc. The probe assembly shall be a quick disconnect type for ease of maintenance. The unit shall come standard with one spare replacement probe cartridge. Stainless steel electrodes located in the top and bottom of electrode module shall transmit the generated signal through shielded coaxial cable to the monitor. A timing signal from an optoelectric device in the sensor module shall be transmitted through a shielded twisted pair to the monitor.
- 2.5.5 The control module shall contain all circuitry and signal processing cards to provide outputs of 4-20 mA, 0 to 10 VDC, -10 to +10 VDC, reference outputs and HIGH/LOW alarm contacts. The monitor shall have control and self-diagnostic functions as follows: (1) Adjustable High and Low alarm settings and relay contacts for both.. (2) Meter zero adjustment, full scale on all ranges. (3) Signal gain switch adjustable 1X, 2X, 5X, 10X, 20X. (4) Internal, continuous adjustment for higher gain. (5) Digital LED display with -10.00 to +10.00 span. (6) Flashing LED sensor operation light. Monitor shall be wall mounted.
- 2.5.6 The Streaming Current Monitor shall automatically control the alum metering pumps based on the streaming current monitor. The Contractor shall provide a control wiring and conduit between the streaming current monitor and alum metering pumps to accomplish this function. The instrument shall be a Streaming Current Monitor Model 2000XR with Dura Trac Sensor as manufactured by Chemtrac Systems, Inc. Norcross, Georgia.

## **2.6 CHLORINE RESIDUAL ANALYZER**

- 2.6.1 Chlorine analyzer with automatic self-testing diagnostic capabilities that performs a complete analysis of the sample every 2.5 minutes. The unit shall utilize the DPD colorimetric method based on Method 408.E in the Standard Methods for Drinking Water (Latest Edition).

- 2.6.2 Analyzer: The analyzer shall have a range of 0 to 5 mg/L, 0.01 mg/L - resolution and automatic color and turbidity compensation. The unit shall have dual alarm outputs with individual, adjustable set points. The unit shall be able to be switched from analyzing free chlorine to total residual by changing the reagents.
- 2.6.3 Sample Conditioning Equipment: Provide pressure regulator, strainer kit and flow meter as required.
- 2.6.4 Enclosure: NEMA 12 for indoor locations and NEMA 4X for outdoor locations. Outdoor enclosures shall be supplied with a thermostat controlled space heater and corrosion-inhibitor blocks. Outdoor enclosures shall be provided with adequate sunscreens.
- 2.6.5 Accuracy:  $\pm 0.5$  percent of scale or  $\pm 0.05$  mg/L, whichever is greater.  
Power Supply: 120 VAC.  
Power Cord: Provide standard 3-prong, 120 VAC male plug and three feet of power cord as scheduled below. Plug and cord shall meet Division 16 requirements.
- 2.6.6 The chlorine residual analyzer shall monitor the finished water chlorine residual as noted on the plans.
- 2.6.7 Acceptable Manufacturer Hach Model CL17.

## 2.7 FLUORIDE RESIDUAL ANALYZER

- 2.7.1 Fluoride analyzer to monitor finished water fluoride levels shall be furnished with automatic self-testing diagnostic capabilities that performs a complete analysis of the sample every 4.2 minutes. The analyzer shall measure fluoride using ion-selective electrode technology.
- 2.7.2 Analyzer: The analyzer shall have a range of 0.1 j to 10 mg/L, 0.01 mg/L resolution and automatic color and turbidity compensation. The unit shall have dual alarm outputs with individual, adjustable set points.
- 2.7.3 Sample Conditioning Equipment: Provide pressure regulator, strainer kit and flow meter as required.
- 2.7.4 Enclosure: NEMA 12 for indoor locations and NEMA 4X for outdoor locations. Outdoor enclosures shall be supplied with a thermostat controlled space heater and corrosion-inhibitor blocks. Outdoor enclosures shall be provided with adequate sunscreens.
- 2.7.5 Accuracy:  $\pm 0.5$  percent of scale or  $\pm 0.05$  mg/L, whichever is greater.  
Power Supply: 120 VAC. Power Cord: Provide standard 3-prong, 120 VAC male plug and three feet of power cord as scheduled below. Plug and cord shall meet Division 16 requirements.

2.8 CHEMICAL DAY DANK SCALES

- 2.8.1 A quantity of seven (7) chemical scales of 4,000 lbs. capacity shall be provided and shall be of the digital readout/electronic load cell type and installed as shown on the plans for the following chemical solution 300 gallon day tanks:

Filter Aid

Fluoride

Ferric

Caustic

Sodium Hypochlorite

Phosphate

Sodium Permanganate

- 2.8.2 Scale platform shall be sized to accept a 48 inch diameter tank. Four (4) adjustable hold down lugs shall be provided on the platform to increase lateral stability and to allow the use of hold down straps for securing the vessel to the platform. Platform scale coating system shall be a minimum dry thickness of 80 mils and be resistant to moisture, chemicals, abrasion, impact and UV light.
- 2.8.3 Scale shall be of the single load cell design. Weight shall be transferred via a pivoted platform to a single, NTEP approved load cell of the shear beam strain gauge type. Flexible cable shall connect load cell to indicator to allow easy remote installation of the readout. Cable length shall be 20 ft.
- 2.8.4 Indicator shall monitor one (1) channel. The remote mounted LCD indicator shall carry CE marking and shall be housed in a NEMA 4X, UL approved enclosure. All operations shall be keypad operated & menu driven in order to avoid compromising the NEMA 4X seal at anytime. The alphanumeric LCD readout shall have backlighting for readability in low light conditions. Power requirement shall be 110 vac.
- 2.8.4 A 6 digit numerical display shall give operator the ability to monitor chemical by weight (lb or kg) or volume (gallons or liters). A bar graph display shall read 0-100% for the net contents. A dual mode TARE key shall allow user to enter the tare weight of the vessel or enter the net weight of the chemical depending on application needs. A diagnostics menu shall allow recalibration without the need to apply field test weights. A user adjustable filter function shall stabilize

display in the event of vibration from pumps or mixers in the immediate vicinity of the scale.

- 2.8.5 Indicator shall output net weight via a 4-20mA signal and full scale output shall be user adjustable via the keypad. Indicator shall have four adjustable set points to display low or high level conditions on the indicator.
- 2.8.6 Scales shall carry a Full Five (5) Year Factory Warranty. "Limited" Warranties shall be considered unacceptable. Full scale accuracy shall be better than 1/4 of 1%. Scale shall be CHEM-SCALE™ with TUF-COAT™ coating, Model 50-DR40LP , and SOLO® G2 digital display Model SRG2-1 (1 or 2 channel), as manufactured by FORCE FLOW, 2430 Stanwell Drive, Concord, CA 94520 USA ([www.forceflow.com](http://www.forceflow.com)).

## 2.9 PRESSURE GAUGES

- A. Type: Bourdon tube or bellows, as required by pressure range, with blowout protection. Provide glycerin-filled gauge as required by schedule.
- B. Dial: 4.5-inch, white face with black lettering.
- C. Materials:
  - 1. Case: Phenolic.
  - 2. Lens: Acrylic.
  - 3. Bourdon Tube and Socket: 316 stainless steel (bronze and brass if diaphragm seal is used).
  - 4. Movement: Stainless steel.
- A. Accuracy:  $\pm 0.5$  percent (Grade 2A).
- F. Connection Size/Location: 1/2 inch/lower.
- G. Snubber 316 stainless steel as required by schedule.
- H. Diaphragm Seal: As required by schedule, provide diaphragm seal with flushing connection:
  - 1. Seal: Welded diaphragm.
  - 2. Upper Housing Material: Carbon steel.
  - 3. Lower Housing Material: 316 stainless steel.
  - 4. Upper Connection: 1/2 inch NPT.
  - 5. Lower Connection: 1 inch NPT.
  - 6. Diaphragm Material: 316 stainless steel.
  - 7. Fluid Fill: Glycerin.



I. Schedule

Item	Tag	Description
1	PI-	Train #1 Filtrate Pump Suction Pressure
2	PI-	Train #1 Filtrate Pump Discharge Pressure
3	PI-	Backwash Pump #1 Discharge Pressure
4	PI-	Air Scour Blower #1 Discharge Pressure
5	PI-	Air Scour Blower #1 Inlet Pressure
6	PI-	High Service Pump #1 Discharge Pressure
7	PI-	High Service Pump #2 Discharge Pressure
8	PI-	High Service Pump #2 Discharge Pressure
9	PI-	Air Scour Blower #1 Discharge Pressure

J. Acceptable Manufacturers: Ashcroft, Dwyer, U.S. Gauge.

2.10 Intrusion Detector

There shall be provided and installed four (4) pyroelectric, hermetically sealed, dual element infrared detectors. The detectors shall be an Arrowhead Technologies Model IR202 or equal.

2.11 Bulk Chemical Storage Tank Level Transmitters

**PART 3 EXECUTION**

- 3.1 Install the instrumentation and control system, with all of its component parts and accessories, in strict accordance with the requirements and recommendations of the manufacturers.
- 3.2 Obtain the services of the manufacturer's factory service engineer to check the installation of equipment and make any field adjustments necessary to ensure proper operation. The service engineer shall certify to the A/E in writing that the equipment has been satisfactorily installed and adjusted for continuous operation.

**GENERAL PROVISIONS**

**Part1 – GENERAL**

**1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 specification sections, apply to work of all Division 16 sections.

**1.02 DESCRIPTION OF WORK**

- A. Part of the electrical work is indicated by Contract Drawings and/or in Division 16 Specifications sections.
- B. Part of the electrical work is indicated on approved shop drawings and installation instructions for water processing equipment and associated control systems.
- C. Part of the electrical-work is indicated on approved SCADA system drawings.

**1.03 CONTRACT DRAWINGS**

- A. Drawings indicate general layout and operational requirements of electrical equipment and systems. Do not scale drawings for equipment sizes or exact locations.
- B. The drawings do not show all the work associated with the installation of the process systems. Refer to approved submittal drawings for requirements for installation and wiring of power, control, and instrumentation equipment.
- C. Do not deviate from requirements of drawings and specifications without written approval from Engineer.

**1.04 QUALITY ASSURANCE**

- A. Material, equipment, and installation shall meet requirements of the edition in effect at project location of the National Electrical Code (NFPA 70) and all applicable local codes.

- B. All electrical material and equipment shall bear the UL label except in cases where UL does not label such types of materials and equipment.
- C. In the event of conflict between the drawings and specifications and the requirements of the applicable codes, the most stringent requirements shall prevail.

#### **1.05 SUBMITTALS**

- A. Submit, to the Engineer, manufacturer's data and shop drawings on equipment and materials as required by other sections of this specification. Clearly indicate proposed substitutions and deviations from contract drawings and specifications.
- B. Proposed substitutions and deviations from the drawings and specifications that are not clearly indicated are hereby rejected.
- C. Approval of product data and shop drawings is not to be interpreted as permitting departure from contract documents.
- D. Contractor shall approve submittals of product data and shop drawings before submission to the Engineer. Approval by the Contractor will indicate general suitability for the application intended and that physical dimensions have been compared with installation space available and no interference will occur.
- E. Deliver to the Owner three (3) copies of a manual compiled in accordance with Division 1 of these specifications. Manual shall include record documents relating to the electrical equipment and systems including maintenance procedures and parts lists.
- F. Deliver to the Engineer one set of record drawings neatly marked up to describe the electrical systems as installed. Record drawings shall show routing of all conduits and dimensioned locations of all underground and underfloor conduits.

### **Part 2 – PRODUCTS**

#### **1.01 MANUFACTURERS**

- A. Subject to compliance with the requirements, provide products of one of the manufacturers named unless the product of an approved equal is specifically indicated as being acceptable.

## **2.02 NAMEPLATES**

- A. Nameplates shall be made of laminated plastic with a white center core sandwiched between two black layers. Letters shall be engraved, white, 3/8" high.

## **2.03 SUPPORTING MATERIALS**

- A. Supporting material shall be complete with necessary accessories to make a complete installation.
- B. Supporting material shall be galvanized steel unless indicated otherwise.

## **2.04 COMMUNICATION TERMINAL BOARD**

- A. Telephone terminal backboard shall be made of 3/4" marine grade plywood, painted with two coats of non-conductive, fire-retardant paint, flat gray, and be 4" by 8' unless indicated otherwise.
- B. Cable system terminal backboard shall be made of 3/4" marine grade plywood, painted with two coats of non-conductive, fire-retardant paint, flat gray, and be 4" by 8' unless indicated otherwise.

# **Part 3 – EXECUTION**

## **3.01 INSTALLATION**

- A. Examine areas and conditions under which electrical equipment is to be installed and notify Engineer in writing of any conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Install electrical systems as indicated, complying with each respective manufacturer's written instructions, requirements of the applicable codes and standards, and in accordance with recognized industry practices.
- C. Do not route any conduits through or within structural beams or columns.

## **3.02 COORDINATION**

- A. Coordinate installation of new electrical services with local electric utility company. Provide concrete pads, trenching, conduit, connections, current transformer enclosures, meter bases and other facilities as required by local electric utility and in accordance with current local requirements.
- B. Coordinate with local telephone company for new telephone service. Provide conduit, size as indicated, from telephone service point to telephone terminal board.
- C. Coordinate with local cable television company for new cable television service. Provide conduit, size as indicated, from cable television service point to telephone terminal board.
- D. Coordinate with other trades and approved submittals for requirements for additional electrical equipment, connections, and wiring as necessary for proper operation of all systems and equipment.
- E. Coordinate with approved submittals for water processing equipment for locations and raceway and wiring requirements for all associated control and instrumentation devices.
- F. Coordinate with approved submittals for Owner furnished equipment for electrical power and control requirements. Notify Engineer immediately of electrical requirements different from those provisions shown on the drawings.
- G. Coordinate with approved submittals of SCADA system for locations and raceway and wiring requirements for all associated control and instrumentation devices.
- H. Coordinate with other trades for information about electrical items such as starters and disconnect switches that may be furnished with equipment.
- I. Coordinate with other trades for locations of mechanical equipment, piping, ductwork, and building features to insure that required working clearances are maintained. Notify Engineer of any interference that cannot be eliminated by minor adjustments.
- J. Coordinate with structural engineer for maximum conduit size and quantity allowed within concrete slabs or walls.
- K. Coordinate with structural engineer for minimum supports between beams for cable tray support.

### **3.03 CONNECTIONS**

- A. Rough-in for equipment connections according to approved equipment submittals.
- B. Provide all equipment connections complete with motor controls, switches, wiring devices, control devices, protective devices, conduit, wiring, and other accessories as necessary for proper operation.
- C. When starters, control devices, or wiring are furnished as part of the controlled equipment, provide equipment connections, safety disconnect switches, conduit and other accessories as required.
- D. Equipment connections shall be as recommended by the manufacturer.
- E. When electrical power requirements are not as provided for in electrical design, propose modifications to accommodate equipment requirements for approval by Engineer.

### **3.04 NAMEPLATES**

- A. Install nameplates on each control panel, panelboard, and motor control center. Nameplate shall show equipment designation, voltage, and source of power.
- B. Install nameplates on each disconnect switch, motor control center compartment, and remote control device. Nameplate shall identify equipment served, protected, or controlled.

### **3.05 INSTRUCTION**

- A. Instruct Owner's representatives in proper operation and maintenance of all electrical systems and equipment.

**END OF SECTION 16010**

## ACCEPTANCE TESTING

### Part 1 – GENERAL

#### 1.01 DESCRIPTION OF WORK

- A. Extent of acceptance testing work is indicated by this and other Division 16 specifications.
- B. Provide the services of a recognized independent testing firm for the purpose of performing inspections and tests as describe here. The testing firm shall provide all the materials, equipment, labor and technical supervision to perform such inspections and tests.
- C. The inspections and tests shall determine the suitability for energization for new equipment and materials.

#### 1.02 QUALITY ASSURANCE

- A. Inspections and testing shall be in accordance with the latest edition of the following:
  - 1. American National Standards Institute!
  - 2. American Society for Testing and Materials
  - 3. Institute of Electrical and Electronic Engineers
  - 4. Insulated Cable Engineers Association
  - 5. InterNational Electrical Testing Association
  - 6. National Electrical Manufacturers Association
- B. The testing firm shall be independent of their manufacturers, suppliers, and installers of the equipment and systems being tested.
- C. The testing firm shall be regularly engaged in the testing of electrical equipment and be a full member of the InterNational Electrical Testing Association. Proof of qualifications shall be submitted with bid documents.

#### 1.03 SUBMITTALS

- A. Submit to the Engineer a written report with records of all observations and measurements taken. Report shall include initial observations and measurements, corrective actions taken, if any, and final observations and measurements.



Part 2 – PRODUCTS

Not applicable.

Part 3 – EXECUTION

3.01 GENERAL

- A. Perform all the inspections and tests of new equipment and materials as listed here. Compare all quantitative measurements with the test values listed in NETA ATS-1995 Acceptance Testing Specifications or, if available, manufacturer's recommendations.

3.02 NEW SWITCHGEAR AND MOTOR CONTROL CENTERS

- A. Visual and Mechanical Inspection:
  - 1. Compare equipment nameplate data with drawings and specifications.
  - 2. Inspect physical, electrical, and mechanical conditions.
  - 3. Confirm correct application of manufacturer's recommended lubricants.
  - 4. Inspect for appropriate anchorage, required clearances, physical damage, and correct alignment.
  - 5. Inspect all doors, panels, and sections for paint, dents, scratches, fit, and missing hardware.
  - 6. Verify that fuse and/or circuit breakers sizes and types correspond to drawings and coordination study.
  - 7. Confirm correct operation and sequencing of electrical and mechanical interlock systems. Attempt closure on lock-open devices and attempt to open locked-closed devices. Make key exchange with devices operated in off normal positions.
  - 8. Inspect insulators for evidence of physical damage or contaminated surfaces.
- 9. Verify correct barrier and shutter: installation and operation.

10. Exercise all active components.
11. Inspect all mechanical indicating devices for correct operation.
12. Verify that filters are in place and/or vents are clear.
13. Perform thermographic survey.

**B. Electrical Tests**

1. Perform ground resistance tests.
2. Perform resistance tests through all bus joints with a low-resistance ohmmeter. Any joints that cannot be directly measured due to insulation wrap shall be indirectly measured from nearest accessible points.
3. Perform insulation resistance tests on each bus section, phase-to-phase and phase-to-ground.
4. Perform phasing check on double-ended switchgear to insure correct bus phasing from each source.

**3.03 NEW CABLES, LOW VOLTAGE**

**A. Visual and Mechanical Inspection:**

1. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
2. Verify tightness of bolted connections by calibrated torque wrench.
3. Perform thermographic survey.
4. Inspect compression-applied connectors for correct cable match and indentation.

**B. Electrical Tests**

1. Perform insulation resistance test on each conductor, size AWG #2 and larger, with respect to ground and adjacent conductors. Applied potential shall be 1000 volts dc for one minute.

**3.04 NEW MOTORS**

**A. Visual and Mechanical Inspection:**

1. Compare equipment with nameplate data and specifications.
2. Inspect physical and mechanical condition.
3. Inspect for correct anchorage, mounting, grounding, connection, and lubrication.
4. Verify tightness of bolted electrical connections.
5. Perform thermographic survey.
6. Perform a rotation test to insure correct shaft rotation direction.

**B. Electrical Tests**

1. Perform insulation resistance test in accordance with ANSI/IEEE Standard 43. Motors larger than 200 horsepower: test duration shall be for ten minutes. Calculate polarization index. Motors 200 horsepower and less: test duration shall be for one minute. Calculate the dielectric absorption ratio.
2. Verify that resistance temperature detector circuits conform to manufacturer's drawings.
3. Measure running current and evaluate relative to load conditions and nameplate full load amperes.
4. Perform vibration tests on motors rated 10 through 200 horsepower. Determine vibration amplitude.

**3.05 NEW MOTOR STARTERS, LOW VOLTAGE**

**A. Visual and Mechanical Inspection:**

1. Compare equipment nameplate data with drawings and specifications.
2. Inspect physical and mechanical condition.
3. Verify that overload element rating is correct for motor full load current rating.
4. Verify tightness of bolted connections.
5. Perform thermographic survey.

**B. Electrical Tests:**

1. Perform insulation resistance test of each combination starter, phase-to-phase and phase-to-ground, with the starter contacts, closed and the protective device open.
2. Perform operational tests by initiating control devices.

**3.06 NEW GROUNDING SYSTEMS**

**A. Visual and Mechanical Inspections:**

1. Verify ground system is in compliance with drawings and specifications.

**B. Electrical Tests**

1. Perform fall-of-potential test or alternative in accordance with IEEE Standard 81-1991 on the service grounding systems.
2. Perform point-to-point tests to determine the resistance between the main grounding systems and all major electrical equipment frames, system neutrals, and/or derived neutral points.

**END OF SECTION 16090**

**RACEWAYS**

**Part 1 – GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of raceway work is indicated by drawings and specified in other Division 16 sections.

**Part 2 - PRODUCTS**

**2.01 GENERAL**

- A. Provide raceways of types and sizes as indicated, including bushings, couplings, offsets, elbows, expansion joints, adapters, and other components as needed for complete system.
- B. Minimum raceway size shall be  $\frac{3}{4}$ ", unless noted otherwise.
- C. Feeder raceway sizes indicated are based on copper conductors.
- D. Where types and sizes are not indicated, provide raceways as required to fulfill requirements and comply with the latest version of the National Electrical Code, as approved by Kentucky Electrical Division Department of Housing, Buildings and Construction.

**Part 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Coordinate with approved equipment submittals for power and control wiring conduits required for process equipment but are not indicated on drawings.
- B. Install non-metallic (PVC) conduit, schedule 40, inside buildings except as noted, under slabs on grade, and underground outside buildings. Provide RSC elbow and vertical section on PVC conduit entering floor or ground.
- C. Install conduits that originate and terminate inside building above the floor.
- D. Install flexible liquid-tight conduit for motor connections and for other electrical equipment connections where subject to movement and vibration.

- E. Size conduits for control and/or signal wiring as required for the conductors to be installed.
- F. Use metallic conduit for low voltage and 4-20 milliamp signal and control wiring.

**3.02 INTERIOR CONDUIT**

- A. Install conduit exposed on walls and suspended from structure except as noted below.
- B. Install EMT or MC conduit in office area, control room, and file room concealed in walls and above lay-in ceilings.
- C. Install all conduits parallel or perpendicular to walls.
- D. Provide UL listed fire wall/floor penetration techniques where conduit penetrates fire rated walls or floors. See architectural drawings for identification of fire rated walls.

**3.03 EXTERIOR CONDUIT**

- A. Install underground conduit for electrical service —entrance conductors encased in minimum 2 inches of concrete.
- B. Underground Schedule 80 PVC conduits not encased in concrete shall be protected with 3" of sand on all sides.
- C. Install yellow plastic warning strip above buried raceways and 6" below finished grade.

**3.04 SEALING**

- A. Install Watertight sealing fittings in underground conduits at termination points in electrical enclosures.

**3.05 PULL WIRES**

- A. Provide pull wires in, and insulating bushings on, all conduits in which wiring is to be installed by others.

**3.06 CLEANING**

- A. After completion of raceway installation, inspect interiors of raceways and remove all dirt and trash.

**3.07 TELEPHONE/DATA/CABLE SYSTEM RACEWAY**

- A. Install 3/4" conduit, or as required for wiring, from each telephone/data system outlet to telephone terminal board or associated control device; or control panel.
- B. Install a telephone service raceway, one 3" PVC conduit unless noted otherwise, from telephone terminal board to telephone service location.
- C. Install a cable service raceway, one 2" PVC conduit unless noted otherwise, from data cable service location to cable terminal board.

**END OF SECTION 16110**

**WIRE AND CABLE**

**Part 1 - GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of electrical wire and cable work is indicated on drawings and/or specified in other Division 16 sections.

**1.02 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver wire and cable packaged in factory containers.
- B. Store wire and cable in clean dry space protected from damaging fumes, construction debris, and traffic.
- C. Handle wire and cable carefully to avoid damaging insulation or sheathing.

**Part 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Power wire and-cable:
  - 1. AFC
  - 2. Anaconda
  - 3. Kerite
  - 4. Rome
  - 5. Southwire
  - 6. Triangle PWC
- B. Cable for signal, data, and control:
  - 1. Belden
  - 2. West Penn
  - 3. General Cable

**2.02 POWER WIRES AND CABLES**

- A. Feeder Circuits - Provide copper, or aluminum, wires with Type THHN, or THWN insulation, of sizes indicated. Where sizes are not indicated, provide proper size wire to comply with the National Electrical Code.



- B. Branch Circuits - Provide copper wires with Type THHN, or THWN insulation, of sizes indicated. Where sizes are not indicated, provide proper size wire to comply with the National Electrical Code.
- C. Provide type MC cable with separate green insulated equipment grounding conductor.
- D. Provide type TC cable with separate green insulated equipment grounding conductor.
- E. Provide VFD rated conductors or cables as required by VFD controlled equipment. Double separate green insulated equipment grounding conductor

### 2.03 SIGNAL, DATA, AND CONTROL CABLES

- A. Provide factory fabricated copper cables of sizes and sheathing as indicated. Where not indicated, provide proper cables to comply with requirements.
- B. Provide cables with characteristics as specified in approved submittals.

## Part 3 – EXECUTION

### 3.01 INSTALLATION

- A. Install all wiring in conduit except as indicated below. Pull conductors simultaneously where more than one is being installed in the same raceway.
- B. Type MC cable may be used for branch circuits rated at 20 amps where run concealed above ceilings and within walls in office area.
- C. Install data and control cables from instruments and devices to control panels, control room, and/or SCADA room as required by other sections of specifications and/or approved submittals.
- D. Install shielded cable in separate conduits from 120 volt circuit conductors.
- E. Install control and data cables as described in approved submittals.

### 3.02 PULLING

- A. Use pulling compound or lubricant where necessary. Compound must not cause deterioration of insulation.

**3.03 SPLICES**

- A. Install splices and taps which possess equivalent or better ampacity, mechanical strength, and insulation ratings than conductors being spliced. Use splice and tap connectors which are compatible with conductor material.

**3.04 TIGHTENING**

- A. Tighten electrical connections in accordance with manufacturer's published torque tightening values or to comply with tightening torques specified in UL Std 486A and B.

**3.05 TESTING**

- A. Subsequent to wire and cable connections, energize circuitry and demonstrate proper functioning.

**END OF SECTION 16120**

**ELECTRICAL BOXES AND FITTINGS**

**Part 1 - GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of electrical box and associated fitting work is indicated on drawings and/or specified in this or other Division 16 sections.

**Part 2 -PRODUCTS**

**2.01 DEVICE AND OUTLET BOXES**

- A. Provide nonmetallic device and outlet boxes of sizes as required.
- B. Provide boxes for electrical devices as well as for telephone, data, instrumentation, control, and signal systems.
- C. Provide device and outlet box accessories as required that are compatible with boxes being used.

**2.02 JUNCTION AND PULL BOXES**

- A. Provide galvanized, welded seam, sheet steel junction and pull boxes of sizes as required. Boxes shall have screw-on covers and stainless steel screws.

**2.03 BUSHINGS, KNOCKOUT CLOSURES AND LOCKNUTS**

- A. Provide corrosion-resistant knockout closures, conduit locknuts, and conduit bushings of types and sizes as required.

**Part 3 - EXECUTION**

**3.01 COORDINATION**

- A. Coordinate installation of electrical boxes and fittings with architectural finishes, casework, mechanical equipment, structural features, and wall-mounted equipment and devices

**3.02 WEATHERTIGHT BOXES**

- A. Provide weathertight boxes for locations exposed to weather or moisture. Provide watertight boxes for underground installation.

**3.03 CLOSURES**

- A. Provide knockout closures to cap unused knockout holes where blanks have been removed.
- B. Provide covers on all pull boxes and junction boxes.
- C. Provide blank covers on all device and outlet boxes left for future use.

**3.04 INSTALLATION**

- A. Install electrical boxes as required to ensure accessibility to electrical wiring. Fasten boxes to structural members or embed in concrete.
- B. Install boxes exposed except as noted below.
- C. Install boxes recessed in office area, control room, and file room.
- D. Position recessed outlet boxes level and plumb.
- E. Clean all boxes prior to installation of wiring or devices

**END OF SECTION 16130**

**WIRING DEVICES**

**Part 1 – GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. The extent of wiring device work is indicated on drawings.

**1.02 SUBMITTALS**

- A. Submit manufacturer's data on wiring devices.

**Part 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Receptacles, Switches, and Wallplates:

General Electric

Hubbell

Leviton

Pass and Seymour

**2.02 GENERAL**

- A. Provide factory fabricated wiring devices of types and electrical ratings indicated.
- B. Provide ivory color devices and coverplates in office area.
- C. Provide gray color devices and stainless steel coverplates in plant areas.

**2.03 DUPLEX RECEPTACLES**

- A. Provide specification grade duplex receptacles, 2- Pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke.
- B. Duplex receptacles shall be rated 20 amperes, 125 volts, NEMA 5-20R, unless indicated otherwise.
- C. All receptacles in wet locations, outdoors, and on roofs shall be ground fault interrupter type.

**2.04 MISCELLANEOUS RECEPTACLES**

- A. All other receptacles shall be of same quality as general duty duplex type. Ratings shall be as indicated.

**2.05 GROUND FAULT INTERRUPTER RECEPTACLES**

- A. Provide termination type ground fault circuit interrupter duplex receptacles, grounding type rated 20 amperes, 120 volts, 60 Hz, with solid-state ground-fault sensing, 5 milliamperes trip level, NEMA 5-15R.

**2.06 SWITCHES**

- A. Provide specification grade switches, 20 ampere, 120/277 volts AC, with mounting yoke insulated from mechanism. Switch shall be single pole, two-pole, three-way, or four-way as described on drawings.

**Part 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Install wiring devices in clean electrical boxes after wiring work is complete. Install wallplates after painting work is complete.

**3.02 GROUNDING**

- A. Provide equipment-grounding connections for wiring devices.

**3.03 TESTING**

- A. Test each wiring device for proper operation and proper polarity. Make corrections as necessary.

**END OF SECTION 16140**

**MOTOR STARTERS**

**Part 1 – GENERAL**

**1.01 DESCRIPTION OF WORK:**

- A. The extent of motor starter work is indicated on drawings and/or specified in other Division 16 sections.

**1.02 SUBMITTALS:**

- A. Submit manufacturer's data on motor starters.
- B. Submit control wiring diagrams for each magnetic motor starter.

**Part 2 - PRODUCTS**

**2.01 MANUFACTURERS:**

- A. Magnetic and manual starters:
  - 1. Allen-Bradley
  - 2. General Electric
  - 3. Siemens

**2.02 GENERAL:**

- A. Provide motor starters of sizes, types, and with features as indicated, or as required by equipment to be controlled.

**2.03 MAGNETIC STARTERS:**

- A. Provide alternating-current starters of types, sizes, ratings, features, and NEMA enclosures indicated. Equip starters with manual reset overload relays.

**2.04 MANUAL STARTERS:**

- A. Provide single-phase manual motor starters, of sizes and ratings indicated. Equip with manually operated quick-make, quick-break toggle mechanisms and one-piece melting alloy type thermal units. Starter to become inoperative when thermal unit is removed. Provide starters with green pilot lights and switch capable of being padlocked OFF.

Part 3 - EXECUTION

3.01 INSTALLATION:

- A. All starters except manual motor starters and where indicated otherwise on drawings, shall be installed in a motor control center.

3.02 CLEANING:

- A. Clean and paint scratched or marred surfaces to match original finish.

3.03 TESTING:

- A. Test each starter, including all control devices, for proper operation. Make corrections as necessary.

END OF SECTION 16155



## VARIABLE FREQUENCY DRIVE CONTROLLERS

### Part 1 – GENERAL

#### 1.01 DESCRIPTION OF WORK

- A. Extent of variable frequency drive controller work is indicated in drawings and specified in this section.

#### 1.02 QUALITY ASSURANCE

- A. The manufacturer of the variable frequency drive shall be a certified ISO 9001 facility.
- B. The drive and all associated optional equipment shall be UL listed according to the Power Conversion Equipment UL 508C. A UL label shall be attached inside each enclosure.
- C. The drive shall be designed, constructed, and tested in accordance with NEMA, NEC, VDE, and IEC standards.
- D. Each drive shall be tested with a 100 percent loaded motor in an environmental chamber at 104 degrees C. All door mounted pilot devices shall be tested and the drive shall be submitted to a hi-pot test. Documentation of the success of these tests; shall be provided upon request of Engineer or Owner.

#### 1.03 SUBMITTALS

- A. Submit manufacturer's data on variable frequency drive controllers including power and control wiring diagrams, dimensioned enclosure drawings, voltage and current ratings, and horsepower ratings.
- B. Submit maintenance and operation manuals with recommended replacement parts lists.

### Part 2 - PRODUCTS

#### 2.01 MANUFACTURERS:

- A. Variable frequency drive (VFD) units shall be manufactured by the same manufacturer of the Motor Control Center specified in Section 16920, and shall be Allen-Bradley or equal.
- B. The VFD and all associated optional equipment shall be UL listed or recognized. The VFD shall contain a UL label attached on the inside of the enclosure cabinet. All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system and must be registered to ISO

9001 and regularly reviewed and audited by a third party registrar. The VFD shall be factory pre-wired, assembled and tested as a complete package.

- C. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first. This warranty applies to variable frequency drive systems.
  
- D. The VFD's specified herein shall be Allen-Bradley Model Powerflex 753 or engineered approved equal. Certifications required for any approved VFD shall include:
  - 1. Listed to UL508C and CAN/CSA-C22.2 No. 14-05
  - 2. In conformity with EMC Directive (2004/108/EC) and Low Voltage Directive (2006/95/EC). Standards applied; EN 61800-3:2004, EN 61800-5-1:2007
  - 3. TÜV Rheinland - standards applied: EN 61800-3:2004, EN 61800-5-1:2007, EN ISO 13849-1:2008, EN ISO 13849-2:2003, EN 61800-5-2:2007, EN 61508 PARTS 1-7:2000, EN 62061:2005, and EN 60204-1:2006
  - 4. Australian Communications and Media Authority. In conformity with Radiocommunications Act: 1992, Radiocommunications Standard: 2008, and Radiocommunications Labeling Notice: 2008. Standards applied: EN 61800-3:2004
  - 5. Electric Power Research Institute. Certified compliant with standards SEMI F47 and IEC 61000-4-34
  - 6. Russian GOST-R Certificate No. POCC US.ME92.H00040
  - 7. Compliant with the European "Restriction of Hazardous Substances" Directive
  
- H. VFD hardware requirements include:
  - 1. Utilize diode bridge or SCR bridge on the input rectifier.
  - 2. Utilize DC bus inductor on all six-pulse VFDs only.
  - 2. Utilize switching logic power supply operating from the DC bus.
  - 3. Incorporate phase to phase and phase to ground MOV protection on the AC input line.
  - 4. Microprocessor based inverter logic shall be isolated from power circuits.
  - 5. Utilize latest generation IGBT inverter section.
  - 6. Battery receptacle for Lithium battery power to the Real Time Clock.
  - 7. Additional DPI port for handheld and remote HIM options.
  - 8. Dedicated Digital Input for hardware enable.
  - 9. Coated printed circuit boards.
  - 10. Optional onboard 24V DC Auxiliary Control Power Supply.
  
- I. Control Logic requirements include:
  - 1. Ability to operate with motor disconnected.
  - 2. Provide a controlled shut down, when properly protected, with no component failure in the event of an output phase to phase or phase to ground short circuit. Provide annunciation of the fault condition.
  - 3. Provide multiple programmable stop modes including Ramp, Coast, DC-Brake, Ramp-to-Hold, Fast Braking, and Current Limit Stop.
  - 4. Provide multiple acceleration and deceleration rates.

5. Adjustable output frequency up to 650Hz.

J. DeviceLogix Control

1. Ability to control outputs and manage status information locally within the VFD.
2. Ability to function stand-alone or complimentary to supervisory control.
3. Ability to speed reaction time by processing in the VFD.
4. Ability to provide scaling, selector switches, or other data manipulations not already built into the VFD.
5. Ability to read inputs/write outputs and exclusively control the VFD.
6. Ability to provide an option for decision making if communication is lost with main controller.
7. Ability to control other VFDs via a peer-to-peer EtherNet/IP network.
8. Ability to write programs off-line.

K. Motor Control Modes

1. Selectable Sensorless Vector, Flux Vector, V/Hz, and Adjustable Voltage Control modes selectable through programming.
  1. The drive shall be supplied with a Start-up and Auto-tune mode.
  2. The V/Hz mode shall be programmable for fan curve or full custom patterns. Capable of Open Loop V/Hz. Current Limit
  3. Programmable current limit from 20 to 160% of rated output current.
  4. Current limit shall be active for all drive states: accelerating, constant speed and decelerating.
  5. The drive shall employ PI regulation with an adjustable gain for smooth transition in and out of current limit.
2. Acceleration / Deceleration
  1. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 3600 seconds.
  2. A second set of remotely selectable accel/decel settings shall be accessible through digital inputs.
3. Speed Profiles
  1. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S Curve" profiles that provide changing accel/decel rates.
  2. S Curve profiles shall be adjustable.
4. Adjustments
  1. A digital interface can be used for all set-up, operation and adjustment settings.
  2. All adjustments shall be stored in nonvolatile memory (EEPROM).
  3. No potentiometer adjustments shall be required.
  4. EEPROM memory for factory default values shall be provided.
  5. Software must be available for trending and diagnostics, as well as online and offline programming functionality.
5. Process PID Control
  1. The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.

2. The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the set-point, the regulator shall adjust the drive output until the feedback equals the reference.
3. Process control shall be capable of being enabled or disabled with a hardwire input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
4. Protection shall be provided for a loss of feedback or reference signal.
6. Skip Frequencies
  1. Three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.
  2. The set points shall have a bandwidth adjustable from Maximum Reverse Speed to Maximum Forward Speed

7. Fault Reset / Run
  1. The drive shall provide up to nine automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
  2. The automatic mode shall not be applicable to a ground fault, shorted output faults and other internal microprocessor faults.
  3. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.
8. Run on Power Up
  1. A user programmable restart function shall be provided to allow restart of the equipment after restoration of power after long duration power outages. Restart time dependent on presence of incoming signal.
9. Fault Memory
  1. The last 32 fault codes shall be stored and time stamped in a fault buffer.
  2. Information about the drive's condition at the time of the last fault such as operating frequency, output current, dc bus voltage and twenty-seven other status conditions shall be stored.
  3. A power-up marker shall be provided at each power-up time to aid in analyzing fault data.
  4. The last 32 alarm codes shall be stored and time stamped for additional troubleshooting reference.
10. Overload Protection
  1. The drive shall provide internal class 10 adjustable overload protection.
  2. Overload protection shall be speed sensitive and adjustable.
  3. A viewable parameter shall store the overload usage.
11. Auto Economizer
  1. An auto economizer feature shall be available to automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage.
  2. When the load increases, the drive shall automatically return to normal operation.
12. Terminal Blocks
  1. Separate terminal blocks shall be provided for control and power wiring.
  2. I/O terminal blocks shall be removable with wiring in place.
13. Flying Start
  1. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. This feature is disabled by default.
14. Inputs and Outputs
  1. The Input / Output option modules shall consist of both analog and digital I/O.
  2. No jumpers or switches shall be required to configure digital inputs and outputs.
  3. All digital input and output functions shall be fully programmable.
  4. The control terminal blocks shall be rated for 115V AC.

5. Inputs shall be optically isolated from the drive control logic.
6. The control interface card shall provide input terminals for access to fixed drive functions that include start, stop, external fault, speed, and enable.
7. The VFD shall be capable of supporting up to 7 analog inputs, 7 analog outputs, 21 digital inputs, 7 relay outputs, 7 transistor outputs, and 3 positive temperature coefficient (PTC) inputs.
8. The Input / Output option modules shall have the following features:
  - i. Analog Inputs:
    1. Quantity two (2) differentially isolated,  $\pm 10\text{V}$  (bi-polar), 88k ohm input impedance, 11 bit plus sign.
    2. Analog inputs shall be user programmable for a variety of uses including frequency command and process loop input. Analog inputs shall be user programmable for function scaling (including invert), offset, signal loss detect and square root.
  - ii. Analog Outputs:
    1. Quantity two (2)  $\pm 10\text{V}$  (bi-polar) / 11 bit & sign, 2 k $\Omega$  minimum load, 4-20 mA, 11 bit plus sign, 400  $\Omega$  maximum load.
    2. The analog output shall be user programmable to be proportional to one of fourteen process parameters including output frequency, output current, encoder feedback, output power.
    3. Programming shall be available to select either absolute or signed values of these parameters.
  - iii. Digital Inputs:
    1. Quantity of six (6) digital inputs rated 24V DC/115V AC.
    2. All inputs shall be individually programmable for multiple functions including: Start, Run, Stop, Auxiliary Fault, Speed Select, Jog and Process PI functions.
  - iv. Digital Outputs:
    1. At least one (1) relay output (N.O. or N.C.).
    2. For 240V AC or 24V DC, N.O. contact output ratings shall be 2 amp max., general purpose (inductive)/resistive. N.C. contact output ratings shall be 2 amp max., resistive only.
    3. Relays shall be programmable to multiple conditions including: Fault, Alarm, At Speed, Drive Ready and PI Excess Error.
    4. Timers shall be available for each output to control the amount of time, after the occurring event, that the output relay actually changes state.
    5. At least one (1) transistor output.
    6. For 24V DC, transistor output rating shall be 1 amp max, Resistive.
15. Reference Signals
  1. The drive shall be capable of using the following input reference signals:
    - i. Analog inputs
    - ii. Preset speeds
    - iii. Remote potentiometer

- iv. Digital MOP
  - v. Human Interface Module
  - vi. Communication modules
16. Loss of Reference
- 1. The drive shall be capable of sensing reference loss conditions.
  - 2. In the event of loss of the reference signal, the drive shall be user programmable to the following:
    - i. Fault the drive and coast to stop.
    - ii. Issue a minor fault - allows the drive to continue running while some types of faults are present.
    - iii. Alarm and maintain last reference.
  - 3. When using a communications network to control the drive, the communications adapter shall have these configurable responses to network disruptions and controller idle (fault or program) conditions:
    - i. Fault
    - ii. Stop
    - iii. Zero Data
    - iv. Hold Last State
    - v. Send Fault Configuration
17. Metering
- 1. At a minimum, the following parameters shall be accessible through the Human Interface Module, if installed:
    - i. Output Current in Amps
    - ii. Output Voltage in Volts
    - iii. Output Power in kW
    - iv. Elapsed MWh
    - v. DC Bus Voltage
    - vi. Frequency
    - vii. Heatsink Temperature
    - viii. Last eight (32) faults
    - ix. Elapsed Run Time
    - x. IGBT Temperature

## 18. Faults

1. At a minimum, the following faults shall be accessible through the Human Interface Module:
  - i. Power Loss
  - ii. Undervoltage
  - iii. Overvoltage
  - iv. Motor Overload
  - v. Heat Sink Over-temperature
  - vi. Maximum Retries
  - vii. Phase to Phase and Phase to Ground Faults

## 19. Predictive Diagnostics

1. At a minimum, the following predictive diagnostic features shall be provided:
  - i. Relay Output Life Cycles based on load type and amps.
  - ii. Hours of Fan Life based on load and ambient temperature.
  - iii. Motor Bearing life based on expected hours of use.
  - iv. Motor Lubrication schedule based on hours of use.
  - v. Machine Bearing life based on expected hours of use.

## 20. Real-Time Clock

1. Shall be capable of providing time stamped events.
2. Shall have the ability to be set locally or via a remote controller.
3. Shall provide the ability to be programmable for month, day, year and local time zones in HH:MM:SS.

## L. VFD – MOTOR CONTROL CENTER INSTALLATION

## 1. Enclosure Door Mounted Human Interface Module (HIM)

1. An enclosure door-mounted HIM, rated NEMA/UL Type 1 or NEMA/UL Type 4/12, shall be provided
2. The HIM shall have the following features:
  - i. A seven (7) line by twenty-one (21) character backlit LCD display with graphics capability.
  - ii. Shall indicate drive operating conditions, adjustments and fault indications.
  - iii. Shall be configured to display in the following three distinct zones:
    1. The top zone shall display the status of direction, drive condition, fault / alarm conditions and Auto / Manual mode.
    2. The middle zone shall display drive output frequency.
    3. The bottom zone shall be configurable as a display for either programming menus / information or as a two-line user display for two additional values utilizing scaled units.
  - iv. Shall provide digital speed control.
  - v. The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.



## **2.02 RATINGS**

- A. The variable frequency drive shall operate in a pollution Degree 3 environment with a temperature range of 0 to 40 degrees C and a relative humidity of 95 percent, non-condensing.
- B. The input voltage shall be 460 volts, plus or minus 10 percent, at 58 to 62 Hertz.
- C. The power factor shall be not less than .95 lagging at any speed or load condition,
- D. The drive efficiency shall be not less than 96 percent at full speed and load.
- E. The drive shall be listed for use at an available fault current of 42,000 amps symmetrical, unless indicated otherwise on the drawings, and shall have indication of such on nameplate.

## **2.03 PROTECTION**

- A. Upon power-up the drive shall automatically test for valid operation of memory, option module, loss of analog reference input, loss of communication, dynamic brake failure, DC-to-DC power supply, control power, and the precharge circuit.
- B. The variable frequency drive shall be fully protected against transient voltages with integral transient voltage surge suppressors.
- C. The starter shall be provided with phase loss and phase reversal protection.

## **Part 3 – EXECUTION**

### **3.01 GENERAL**

- A. The variable frequency drive manufacturer shall field test, adjust, and certify all drives for satisfactory operation.

### **3.02 COORDINATION**

- A. Coordinate with all equipment control diagrams and approved vendor drawings to insure that all control and pilot devices are present and operational.
- B. Verify that motor to be driven is NEMA MG1 Part 31 compliant. Provide integral output line reactors in accordance with drive manufacturer's recommendation if the motor is not compliant.

### **3.03 TESTING**

- A. All variable frequency drives shall be tested and initially energized by a manufacturer's representative for proper operation within the requirements as defined by control drawings and approved vendor drawings of associated equipment.

END OF SECTION 16157

**SOLID STATE SOFT STARTERS**

**Part 1 – GENERAL**

**1.01 SCOPE OF WORK**

- A. These specification requirements are for solid-state reduced voltage motor controllers herein referred to as soft starters.

**1.02 QUALITY ASSURANCE**

- A. The soft starter shall be listed by an independent testing laboratory in accordance with UL 508 - Industrial Control Equipment.
- B. The soft starter shall carry the CE mark for indication of compliance to low voltage and EMC directives.
- C. The manufacturer shall be a certified ISO 9002 facility.

**1.03 WARRANTY**

- A. An 18-month warranty shall be provided on materials and workmanship from date of invoice.

**Part 2 - PRODUCTS**

**2.01 MANUFACTURERS:**

- 1. Allen-Bradley
- 2. Danfoss
- 3. General Electric
- 4. Siemens

**2.02 GENERAL DESCRIPTION**

- A. The soft starter shall be installed in a motor control center or as indicated.
- B. Enclosure shall include a door mounted digital keypad for adjusting the starting parameters.
- C. The soft starter shall be provided complete with magnetic only circuit breaker. Short circuit withstand rating shall be based on the motor horsepower as defined in UL 508.
- D. The motor must be automatically protected from solid state component failure.

- E. The soft starter shall provide torque control for linear acceleration without external feedback independent of motor load or type of application. The gating of the thyristors will be controlled in such a manner to ensure smooth and stable acceleration ramp.
- F. The soft starter shall be controlled by a microprocessor that continuously monitors the current and controls the phasing of the SCRs. Analog control algorithms shall not be allowed.
- G. A shorting contactor shall be supplied with soft starters. Protective features and deceleration control options integral to the soft start shall be available even when the shorting contactor is employed.
- H. Provide adjustable time delay relay to delay motor starting after start signal to prevent simultaneous starting of multiple motors on generator power after power interruption.
- I. The control power transformer shall provide 120 volt power for the motor space heater circuit.
- J. The soft starter control circuit shall interlock with the winding temperature sensor in the motor.

## **2.03 RATINGS**

- A. The soft starter shall be designed to operate in an ambient temperature 0°C to 40°C and at a maximum relative humidity of 93% at 40°C, non-condensing.
- B. The soft starter shall be capable of operation within +/-10% of nominal voltage rating and within +/- 5% of frequency rating.
- C. The soft starter shall be capable of supplying 400% of rated full load current for 23 seconds at maximum ambient temperature.
- D. The SCRs shall have a minimum P.I.V. rating of 1800 volts. Lower rated SCRs with protection by MOVs are not acceptable.

## **2.04 ADJUSTMENTS AND CONFIGURATIONS**

- A. All dialogue functions, display units, remote functions, terminal blocks, configuration switches and adjustment potentiometers shall be accessible on the front of the control module.

- B. Digital indication shall provide the following information:
  - 1. Soft start status
  - 2. Motor status
  - 3. Fault status
- C. The starter shall be preset to the following for operation without adjustment in most applications.
  - 1. Torque acceleration ramp of 10 seconds
  - 2. Current limitation to 300% of the motor full load current rating
  - 3. Class 10 overload protection
- D. A digital keypad shall allow adjustment of the following operating parameters as required:
  - 1. Motor full load amps adjustable from 50% to 130% of the controller's rating
  - 2. Current limitation on starting adjustable from 1.5 to 7.0 times rated motor current, not to exceed 5.0 times the controller rating
  - 3. Torque ramp adjustable from 1 to 60 seconds
  - 4. Initial **torque** adjustable from 10% to 100% of nominal motor torque
  - 5. Torque limit adjustable from 10% to 200% of nominal motor torque
  - 6. Maximum start time adjustable from 10 to 999 seconds
  - 7. Voltage boost adjustable from 50% to 100% of the nominal supply voltage
  - 8. Selection of freewheel, soft stop or braking
  - 9. Adjustable soft stop torque ramp time from 1 to 60 seconds
  - 10. Threshold to change to freewheel following a soft stop from 0 to 100% of the nominal motor torque
  - 11. Braking torque level adjustable from 0 to 100% effectiveness
  - 12. Selection of Class 2, 10, 10A, 15, 20, 25 or 30 motor thermal overload protection
- E. A digital keypad shall allow adjustment of the following controller parameters as required:

1. Selectable automatic reset operation
  2. Assignment of controller inputs and outputs
  3. Reset of motor thermal state
  4. Return to factory settings
  5. Indication of elapsed time in hours of starting, running and stopping
- F. Output relays shall provide the following status indications:
1. One form A (N.O.) and one form B (N.C.) minimum for indication of fault or control of an isolation contactor
  2. One form A (N.O.) for indication that torque ramp is complete and current is below 130% motor FLA (End of start)
- G. Additional inputs and outputs shall be available to provide the following status indications:
1. One logic input for force to freewheel, indication of external fault, force to local control, control of cascading motors, or external motor overload reset
  2. One logic output for indication of motor thermal overload pre-alarm or presence of motor current and one logic output to indicate over current alarm
  3. One analog output shall be available for 4 - 20 or **0 - 20** milliamp indication of motor current, torque, thermal state or power factor
- H. Relay and I/O functions listed above must be isolated with respect to common.

## 2.05 PROTECTION

- A. A microprocessor controlled thermal protection system shall be included which continuously calculates the temperature-rise of the motor and soft start and provides
1. An overload pre-alarm, which indicates by relay contact that the motor has exceeded its rated temperature rise by 110%. This function shall be annunciation only.
  2. A thermal fault condition which stops the motor if the temperature rise exceeds 120% of the motor thermal capability.
  3. An analog electronic circuit with a time constant adjustable to the motor's thermal cooling time constant ensuring the memorization of the thermal state even after power supply disconnection or shorting out of the power semiconductors.

- B. The soft starter shall provide phase loss, phase reversal, underload, stall, and jam protection during starting and in bypass mode.

**2.06 CONTROL OPTIONS**

- A. The peripheral soft starter control circuitry shall be operated at 120 Vac 60 Hz from a control power transformer included within the enclosure.
- B. Operator devices shall be door mounted and shall be:
  - 1. Three position H-O-A switch, which provides for manual (HAND) start or remote signal (AUTO) start from user supplied relay contacts.
  - 2. Red or green RUN pilot light illuminated whenever the soft start is provided a run command and no fault condition is present.

**2.07 SHORTING CONTACTOR**

- A. The shorting contactor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating ramp complete) and open on a stop command to allow a deceleration ramp.

**Part 3 – EXECUTION**

**3.01 INSTALLATION**

- A. The soft starter shall be installed per the manufacturer's specifications.

**3.02 START UP**

- A. The services of a qualified manufacturer's technical representative shall be available to install, test, and start up all soft starters furnished under this specification.

**END OF SECTION 16159**

Part 1 – GENERAL

1.01 DESCRIPTION OF WORK

- A. Extent of panelboard work is indicated on drawings.

1.02 SUBMITTALS

- A. Submit manufacturer's data on panelboards with all electrical characteristics clearly identified.

Part 2 –PRODUCTS

2.01 MANUFACTURERS

- A. Panelboards:
  - 1. Cutler-Hammer
  - 2. Eaton
  - 3. Siemens

2.02 GENERAL

- A. Provide dead front, factory-assembled circuit breaker or fused switch type panelboards as indicated. Panelboards shall have ratings, enclosures, and features as indicated and shall comply with manufacturer's standard design and construction.
- B. Panelboards shall be constructed with bus bars of tin plated aluminum or solid copper. The neutral bus shall be insulated from enclosure and the ground bus bolted to enclosure. "Load center" type panelboards are not acceptable.
- C. Equip panelboards with devices as indicated or as required. Where multiple-pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously. Circuit breakers and fused switches shall comply with Section 16180 "Overcurrent Protective Devices."
- D. Panelboards shall be fully rated for interrupting ratings as indicated.

2.03 PANELBOARD ENCLOSURES



- A. Provide galvanized sheet steel enclosures of NEMA types as indicated, or as required, by same manufacturer as panelboards. Enclosures shall have a baked enamel finish over a rust inhibitor coating and be suitable for recessed or surface mounting as indicated.
- B. Enclosures shall have doors with concealed piano hinges, flush locks and keys with all enclosures keyed alike. Equip with interior circuit directory frame, and card with clear plastic covering.

**Part 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Anchor enclosures firmly to walls and structural surfaces such that they are mechanically secure.
- B. Bond ground buses together in two section panelboards. Bonding conductor shall be copper of same size as panelboard feeder ground conductor.

**a. DIRECTORY**

- A. Fill out panelboard circuit directory card upon completion of installation work using a typewriter.
- B. Directory shall describe type of load and location for each branch circuit using Owners' space names or numbers.
- C. Information on directory card shall include name and location of panelboard serving this panelboard.

**3.02 GROUNDING**

- A. Provide equipment-grounding connections for panelboards.

**END OF SECTION 16160**

**MOTOR AND CIRCUIT DISCONNECTS**

**Part 1 - GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of motor and circuit disconnect switch work is generally indicated on the drawings.
- B. Provide safety disconnect switch at each control panel that does not have an integral safety disconnect switch.

**1.02 SUBMITTALS**

- A. Submit manufacturer's data on motor and circuit disconnect switches.

**Part 2 - PRODUCTS**

**2.01 MANUFACTURERS**

- A. Motor and circuit disconnect switches:

Cutler Hammer

Eaton

Siemens

**2.02 GENERAL**

- A. Provide fusible and non-fusible, surface-mounted, enclosed switches of types, and ratings as indicated. Provide quick-make, quick-break switches constructed so that blades are visible in OFF position with door open. Switch shall have an operating handle capable of being padlocked in OFF position. Current carrying parts shall be copper with silver-tungsten Contacts.
- B. Provide disconnect switches with NEMA Type 1 enclosures for indoor locations and NEMA Type 3R enclosures for outdoor locations unless indicated otherwise.
- C. Provide general duty disconnect switches on circuits where the phase-to-phase voltage does not exceed 240 volts unless indicated otherwise on drawings.

- D. Provide heavy duty disconnect switches on circuits with phase-to-phase voltage of 480 volts.

## **2.03 FUSES**

- A. Provide fuses for all fusible switches. Fuses shall comply with Section 16180 "Overcurrent Protective Devices".

## **Part 3 - EXECUTION**

### **3.01 INSTALLATION**

- A. Install disconnect switch within sight of starter location for each hardwired motor driven appliance and at other locations as indicated on Drawings.
- B. Install disconnect switches for use with heating, ventilation, and air conditioning equipment within six feet of units or components.
- C. For interior equipment visible from floor, mount disconnect switch with bottom at 48" above floor.
- D. For exterior equipment mount disconnect switch with bottom at 36" above grade or concrete pad.
- E. Insure that electrical working clearances are maintained at each disconnect switch.

### **3.02 SUPPORT**

- A. Support each disconnect switches from wall or other structural components as close as possible to associated starter or motor. Do not attach disconnect switch to any appliance or equipment housing unless specifically permitted by manufacturer of appliance or equipment.
- B. Provide independent steel channel supports for disconnect switches at appliances and equipment not near a wall.

### **3.03 GROUNDING**

- A. Provide equipment grounding connections for all electrical disconnect switches.

**END OF SECTION 16170**

## OVERCURRENT PROTECTIVE DEVICES

### Part 1 - GENERAL

#### 1.01 DESCRIPTION OF WORK

- A. Extent of overcurrent protective device work is indicated on drawings.

#### 1.02 SUBMITTALS

- A. Submit manufacturer's data on overcurrent protective devices with all electrical characteristics clearly identified.
- B. Submit manufacturer's information indicating that all series rated systems are UL recognized.

### Part 2 - PRODUCTS

#### 2.01 MANUFACTURER

- A. Circuit Breakers:
  - Cutler-Hammer
  - General Electric
  - Siemens
- B. Fuses:
  - Bussmann
  - Littelfuse
  - Reliance/Brush

#### 2.02 GENERAL

- A. Provide circuit breakers and fuses of types, sizes, ratings and characteristics indicated which comply with manufacturer's standard design.
- B. Circuit breakers used for switching lighting shall be listed for switching duty and marked "SWD".
- C. Circuit breakers used on air conditioning and heating equipment circuits shall be listed for that duty and marked "HACR".

#### 2.03 MOLDED CASE CIRCUIT BREAKERS

- A. Provide factory-assembled, molded-case circuit breakers of frame size, trip rating, voltage, poles and interrupting ratings as indicated.
- B. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole and with trip-free type operating mechanisms and positive handle indication. Breakers shall be suitable for operating in any position in an ambient temperature of 40 degrees C.

#### **FUSES**

- A. Circuits rated at 601 to 6000 amps shall be protected by current limiting, UL class L, time delay fuses with a minimum interrupting rating of 200,000 amps symmetrical. Fuses shall be equal to Bussman Low- Peak KRP-C.
- B. Circuits rated at 15 to 600 amps shall be protected by current limiting, UL class RK1, time delay fuses with a minimum interrupting rating of 200,000 amps symmetrical. Fuses shall be equal to Bussman Low- Peak LPN-RX (250 volt) or LPS-RK (600 volts).

#### **Part 3 - EXECUTION**

##### **3.01 INSTALLATION**

- A. Fasten circuit breakers without mechanical stresses, twisting or misalignment being exerted by clamps, supports, or conductors.

##### **3.02 SPARE FUSES**

- A. Provide, to the Owner, three spare fuses of each type and size installed.

##### **3.03 INSPECTION**

- A. Inspect circuit breaker operating mechanisms and adjust units for free mechanical movement.

**END OF SECTION 16180**

**GROUNDING**

**Part 1 - GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Applications of grounding work in this section include the following:
  - 1. Service entrance ground.
  - 2. Separately derived systems.
  - 3. Enclosures.
- B. Requirements of this section apply to electrical grounding work specified elsewhere in these specifications.

**Part 2 - PRODUCTS**

**2.01 GENERAL**

- A. Provide electrical grounding systems as indicated including all accessories needed for a complete installation. Where materials or components are not indicated, provide products complying with NEC and established industry standards.

**2.02 CONDUCTORS**

- A. Provide copper grounding conductors sized according to NEC.

**2.03 GROUND RODS**

- A. Provide copper clad steel ground rods, 10'-0" long and 3/4" in diameter.

**Part 3 - EXECUTION**

**3.01 SERVICE GROUND**

- A. Install a service ground system at each service by bonding together the following:
  - 1. Metal building frame.
  - 2. Metal underground water pipe.
  - 3. Grounding rods.
  - 4. Concrete encased electrode.

- B. Connect ground bus of service entrance equipment to service ground system with a grounding electrode conductor sized in accordance with NEC Table 250-94.
- C. Install grounding electrode conductor in non-metallic conduit.

**3.02 GROUNDING RODS**

- A. Install, and bond together, two ground rods arranged 6 feet apart minimum. Drive ground rods outdoors in an uncovered, unpaved area as near as possible to electrical service entrance.

**3.03 ENCLOSURE GROUNDING**

- A. Install a green-insulated grounding conductor, sized as indicated or as required by the NEC, in each panel feeder conduit and each branch circuit conduit.
- B. Connect green-insulated grounding conductor to each electrical device, box, and equipment enclosure.

**3.04 JUMPERS**

- A. Install braided bonding jumpers with ground clamps on water piping to electrically bypass water meters.

**3.05 TELEPHONE/CABLE SYSTEM GROUNDING**

- A. Provide a #6 copper grounding conductor in 1/2" PVC conduit from the service ground to a junction box at the telephone terminal board.
- B. Provide a #6 copper grounding conductor in 1/2" PVC conduit from the service ground to a junction box at the cable terminal board.

**3.06 CONCRETE ENCASED ELECTRODE**

- A. Install a minimum 20-foot length of #2 bare copper wire near bottom of foundation or footing. Wire shall be encased in minimum of 2" of concrete.

**3.07 TESTING SERVICE GROUND**

- A. Measure the ground resistance of the service entrance ground using the fall of potential method with the ground to neutral link in the service equipment removed. If resistance to ground is over 10 ohms, take appropriate action to reduce resistance to 10 ohms or less by driving additional ground rods and/or by chemically treating soil encircling ground rod.

**END OF SECTION 16450**

**TRANSFORMERS, DRY TYPE**

**Part 1 –GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of transformer work is indicated on drawings.

**1.02 QUALITY ASSURANCE:**

- A. Comply with applicable portions of NEMA Standard Publication No. ST 20-1972 (R 1978) pertaining to dry- type transformers.

**1.03 SUBMITTALS**

- A. Submit manufacturer's data including rated KVA, frequency, primary and secondary voltages, percent taps, impedance, efficiency, average temperature rise above 40 degrees C ambient, and sound level in decibels.

**Part 2 – PRODUCTS**

**2.01 MANUFACTURERS**

- A. Provide products of one of the following:

1. Cutler-Hammer
2. General Electric
3. Siemens

**2.02 GENERAL**

- A. Provide factory-assembled, general-purpose, air-cooled, dry-type distribution transformers of rated capacities indicated, 60 hertz, 10 kV BIL. Primary winding shall have two 2-1/2 % taps above and below rated voltage.
- B. Unless indicated otherwise on drawings, voltage ratio shall be 480 volts delta to 208/120 volts wye.
- C. Transformer surface temperature rise shall be limited to a maximum of 65 degrees C. Terminal compartment temperature shall be limited to 75 degrees C when transformer is operating continuously at rated load with ambient temperature of 40 degrees C. Sound level ratings shall not exceed 45 dB.



- D. Transformers shall be provided with fully enclosed sheet steel enclosures that are electrically grounded to transformer enclosure by means of flexible grounding strap.
- E. Provide transformers with 150 degrees C rise insulation system.

**Part 3 - EXECUTION**

**3.01 INSTALLATION**

- A. Install units on external vibration isolation supports complying with manufacturer's installation instructions.
- B. Where transformers are indicated to be wall mounted, provide additional structural supports as necessary.

**3.02 GROUNDING**

- A. Provide equipment-grounding connections for power distribution transformers.
- B. Ground neutral on secondary side of each delta-wye connected transformer to building steel and metal cold water pipe.

**3.03 TESTING**

- A. Upon completion of installation of transformers, energize primary circuitry at rated voltage and frequency from normal power source and test transformers. Test shall include output voltage and audible sound levels. Correct or replace malfunctioning units and retest.

**END OF SECTION 16460**

**LIGHTING**

**Part 1 – GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of lighting fixture work is indicated on drawings.

**1.02 QUALITY ASSURANCE**

- A. Comply with applicable requirements of NEMA, Standards LE 1 and LE 2 pertaining to lighting equipment.
- B. Provide fluorescent lamp ballasts which comply with Certified Ballast Manufacturers Association; standards and carry the CBM label.

**1.03 SUBMITTALS**

- A. Submit manufacturer's data on lighting fixtures. Submit complete photometric characteristics on proposed substitutions.
- B. Submit list of lamps proposed including manufacturer's name and catalog number.
- C. Submit a photometric plan for the plant lighting for any proposed substitute high bay lighting fixture.

**Part 2 – PRODUCTS**

**2.01 MANUFACTURERS**

- A. Lighting fixtures:
  - As indicated on LIGHTING FIXTURE SCHEDULE or an approved equal.
- B. Lamps:
  - General Electric
  - Philips
  - Sylvania

**2.02 GENERAL**

- A. Provide lighting fixtures of sizes, types, ratings, and with accessories and features indicated.

Substitutions must be of equal quality and photometric performance and similar in appearance to specified fixtures and shall not increase the total lighting load in watts.

- B. Fixtures shall be complete with lamps, ballasts, and all parts, and accessories required for installation and proper operation.
- C. Fixtures mounted outdoors, exposed to weather, shall be UL listed for wet location.

#### 2.03 LAMPS

- A. Provide clear lamps for outdoor fixtures and inside frosted lamps for indoor fixtures unless noted otherwise on drawings.
- B. Incandescent A-lamps shall be extended service type with a minimum of 2500 hours average rated life.
- C. Fluorescent lamps, unless noted otherwise, shall be T8 type.

#### 2.04 BALLASTS

- A. Fluorescent lamp ballasts shall be as described in Lighting Fixture Schedule or, if not described in schedule, as recommended by fixture manufacturer.
- B. HID lamp ballasts shall be as recommended by lamp manufacturer, which properly matches lamps to branch, circuit voltage.

### Part 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Install lighting fixtures at locations and heights as indicated in accordance with fixture manufacturers' instructions. Fasten fixtures securely to structural support and ensure that pendant mounted fixtures are plumb.
- B. High bay lighting fixtures may be shifted a maximum of 24 inches in order to align with structural system. Otherwise install additional fixture support.

**3.02 COORDINATION**

- A. Coordinate with structural members, piping; and ductwork locations for interferences and notify Engineer of any interference that cannot be avoided by minor adjustments in location.

**3.02 CLEANING**

- B. Clean lighting fixtures upon completion of installation. Protect installed fixtures from dirt and damage.

**3.03 TESTING**

- A. Demonstrate proper operation of lighting system. Correct or replace malfunctioning units and retest.

**3.04 GROUNDING**

- A. Provide equipment-grounding connections for each lighting fixture.

**END OF SECTION 16500**

**SURGE PROTECTIVE DEVICES**

**Part 1 –GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Provide surge protective devices (SPD) at the main distribution panel and at other panelboards as indicated.

**1.02 QUALITY ASSURANCE**

- A. Comply with applicable requirements of most recent edition of ANSI/IEEE C62.41, "IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits".
- B. Comply with applicable requirements of most recent edition of UL 1449, "Standard for Safety, Surge Protective Devices".
- C. Provide surge protective device that is UL listed and labeled.
- D. Equipment and installation shall conform to NEC Article 285 "Surge Protective Devices (SPD)".
- E. Provide to the Owner a five-year warranty covering all parts.
- F. Listed voltage protection rating (VPR) indicated below shall be in accordance with the most recent edition of UL 1449.

**1.03 SUBMITTALS**

- A. Submit manufacturer's data and installation instructions for surge protective devices.

**Part 2 – PRODUCTS**

**2.01 MANUFACTURERS**

- A. Subject to compliance with requirements, provide surge protective devices by one of the following:

Advanced Protection Technologies

Current Technologies

## General Electric

## 2.02 GENERAL

- A. Provide solid state, bi-directional SPD with surge current diversion paths for all modes of protection; L-L, L-N, L-G, N-G.
- B. SPD device shall be marked with a short circuit current rating that is equal to, or greater than, the short circuit current rating of the panelboard or switchboard at which it is installed.
- C. Indicator lights shall indicate proper connection and "device failure".
- D. Device failure shall not cause interruption of power to panel or equipment.
- E. SPD equipment that is integral to the panelboard or switchboard is acceptable.
- F. Listed voltage protection ratings (VPR's) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G
120/208V	700V	700V	1200V	700V
277/480V	1200V	1200V	1800V	1200V

## 2.03 SPD AT MAIN DISTRIBUTION PANEL (MDP)

- A. Single pulse surge current capability, per phase, of no less than 120,000 amps.

## 2.04 SPD AT PANELBOARDS

- A. Single pulse surge current capability, per phase, of no less than 80,000 amps.

## Part 3 - EXECUTION

## 3.01 INSTALLATION

- A. Install surge protective devices in accordance with manufacturers' instructions.

- B. SPD shall be mounted integral to motor control centers and attached to enclosure of surface mounted panelboards.
- C. The conductor length from switchboard or panelboard to SPD shall be the absolute minimum possible with no sharp bends. Conductor length shall not exceed 14 inches without approval by Engineer.

END OF SECTION 16603

**STANDBY POWER GENERATOR SYSTEMS**

**Part 1 –GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. Extent of standby power generator system work is described on drawings and/or in these specifications.
- B. Provide and install the standby power generator unit including engine, generator, fuel tank, exhaust silencer, output circuit breaker, enclosure, remote annunciator, and associated transfer switches.
- C. Provide all wiring, conduit, connections, and other materials and labor required to install the standby generator system, and conduct the system testing, as described here and on the drawings.

**1.02 QUALITY ASSURANCE**

- A. Comply with applicable requirements of NEC Articles 700, 701, and 702 pertaining to emergency and standby systems.
- B. Comply with applicable requirements of ANSI/UL 1008, "Standard for Automatic Transfer Switches".
- C. Comply with applicable requirements of ANSI/NEMA MG 1, "Motors and Generators", and MG 2, "Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators".
- D. Comply with NFPA 110 "Standard for Emergency and Standby Power Systems".

**1.03 SUBMITTALS**

- A. Submit manufacturer's data on engine-driven electric generator systems and components including generator transient reactance, available short circuit current, and generator decrement curve. Also submit time current trip curve for generator output circuit breaker and generator thermal damage curve.
- B. Submit layout drawings of engine-driven generator units and accessories including fuel line piping.



- C. Submit field wiring diagrams for engine-driven generator units showing connections to automatic transfer switches, remote annunciator, emergency stop switch, battery charger, battery/enclosure heater, and block heater.
- D. Provide letter of certification of successful factory test of engine-generator system at rated load and rated power factor prior to shipment.
- E. Provide a complete record of installation acceptance on-site testing and of factory testing as part of project closeout documents.

## Part 2 – PRODUCTS

### 2.01 MANUFACTURERS

- A. Provide standby generator systems of one of the following:
  - 1. Caterpillar
  - 2. Generac
  - 3. Kohler
  - 4. Onan

### 2.02 GENERAL

- A. Provide packaged standby power diesel engine-driven generator assembly Unit, with power and voltage ratings as indicated on drawings, for continuous standby operation. The generator shall be capable of providing the output power as indicated at the altitude of the project location. The standby power generator system shall meet all NFPA 110 requirements for a Type 10, Class 24, Level 1 system.
- B. Equip system with control equipment to automatically start engine and transfer essential loads to standby power within 10 seconds after failure of normal power source, transfer load back to normal power upon its restoration, and stop engine.

### 2.03 ENGINE

- A. Provide water-cooled type engine with unit-mounted radiator. Equip engine with a local control panel with "Run-Off-Auto" switch and automatic shutdown, visual alarm, and controls as required by NFPA 110, Section 3-5.5 for a Level 1 installation.

- B. Provide engine with DC powered starting system including starting motor, batteries, and charging generator with automatic charging rate regulator.
- C. Also provide system with an automatic, float type battery charger powered by a 120 volt AC circuit.
- D. Provide exhaust silencer, critical type, with muffler companion flanges and flexible stainless steel exhaust fitting, suitable for horizontal orientation, sized in accordance with engine manufacturer's instructions.
- E. Provide water jacket heater and battery box, heater with contactor to automatically disconnect heaters upon starting of generator. Water jacket heater shall maintain a minimum 90 degrees F temperature.

#### **2.04 FUEL TANK**

- A. Provide diesel fuel tank of capacity as required to operate engine at rated output for a minimum of 24 hours, with positive displacement fuel pump and level indicator. Low-level fuel alarm shall annunciate when enough fuel is left for 8 hours of full load operation.
- B. Fuel tank shall be sub-base mounted, of double wall construction, vented and UL listed.
- C. Provide fuel tank with a monitoring system.

#### **2.05 GENERATOR**

- A. Equip generator with PMG exciter and electronic voltage regulator to maintain voltage within 2% of rated value. Unit shall be capable of voltage recovery, to regulated range, within 7 seconds following sudden load increase from 0 to 100% of rated load with voltage dip not to exceed 20%.
- B. Equip generator with an instrument panel AC ammeter and AC voltmeter for each phase, frequency meter, and voltage-adjusting rheostat.

- C. Equip generator with output circuit breaker with voltage and current ratings as indicated or required and with fault current interrupting rating adequate for generator.

**2.06 REMOTE CONTROLS AND ANNUNCIATION**

- A. Provide remote emergency "Stop" switch for engine generator unit at location indicated.
- B. Provide remote annunciator panel at location indicated with visual and audible alarm to warn of all conditions affecting operation of standby generator as required by NFPA 110, Section 3-5.5.

**2.07 ENCLOSURE**

- A. Provide rust-resistant, weather-protective housing for engine-generator unit, which permits proper cooling, and access to controller and service points.

**2.08 AUTOMATIC TRANSFER SWITCHES**

- A. Provide wall-mounted, three pole, solid neutral, automatic transfer switches, with ratings as indicated on drawings.
- B. Automatic transfer switch shall automatically start standby generator unit when line voltage drops to 70% normal value, transfer load to generator, and transfer load back to normal source when voltage is restored to 90% normal.
- C. Equip electrically operated, mechanically held, transfer switch with limiter to open starting circuit after 45 seconds when engine fails to start. Also provide time-delay features for engine starting to override momentary power dips, load retransfer and engine shutdown.
- D. Equip unit with test switch for manual simulation of power outage and time clock exerciser circuit for automatic periodic exercise of engine-generator unit. Provide auxiliary contacts for elevator control as required.
- E. All contacts, coils, and control elements shall be easily inspectable and conveniently removable from the front of the transfer switch without major disassembly or disconnection of power conductor.

- F. Two identified pilot lights shall be provided to indicate the transfer switch position.
- G. Provide four form C contacts for each position of the transfer switch.

## **2.09 IDENTIFICATION**

- A. Provide a red, engraved, laminated plastic sign on electrical service equipment with describing location of emergency generator: "EMERGENCY GENERATOR LOCATED"
- B. Provide red, engraved laminated plastic signs on remote safety shutdown switches indicating "GENERATOR EMERGENCY STOP".
- C. Provide engraved, laminated plastic sign indicating "AUTOMATIC TRANSFER SWITCH" on each automatic transfer switch.

## **Part 3 - EXECUTION**

### **3.01 GENERAL**

- A. Install standby engine-generator units at locations indicated and in accordance with the manufacturers' instructions.
- B. Install units on vibration isolators and align shafts of engine and generator within tolerances recommended by manufacturer.
- C. Locate emergency stop switch within sight of generator and a minimum of 25 feet away.
- D. Install automatic transfer switches that are not wall mounted on concrete equipment pads.

### **3.02 COORDINATION**

- A. Coordinate location of service access points, on engine-generator unit with clearances available at site. Coordinate with other work, including fuel tanks, piping and accessories, as necessary to interface installation of standby generator system work with other work.

- B. Coordinate location of engine exhaust discharge to insure that exhaust fumes are not drawn into building outside air intakes.

**3.03 GROUNDING**

- A. Provide equipment-grounding connections for engine generator units. Do not connect electrical system neutral conductor to ground conductor at generator. This generator is not a separately derived system.

**3.04 STARTUP AND TESTING**

- A. Inspection of installation and supervision of initial startup shall be by a factory-trained technician.
- B. Perform installation acceptance test of engine generator system, upon completion of installation and in presence of Owner's representative, as described in NFPA 110, Section 5-13.

**END OF SECTION 16620**

**MOTOR CONTROL CENTERS**

**PART 1 - GENERAL**

**1.01 DESCRIPTION OF WORK**

- A. This section includes the requirements for 600V-class low voltage motor control centers (MCCs) for use on alternating current power systems.
- B. The MCCs shall be furnished and installed as specified in this section and as shown on the contract drawings.

**1.02 RELATED SECTIONS**

- A. Section 16010 General Provisions
- B. Section 16090 Acceptance Testing
- C. Section 16110 Raceways
- D. Section 16120 Wire and Cable
- E. Section 16130 Electrical Boxes and Fittings
- F. Section 16140 Wiring Devices
- G. Section 16157 Variable Frequency Drives
- H. Section 16160 Panelboards

**1.03 REFERENCES**

- A. The MCC shall meet or exceed the requirements within the following standards for MCCs.
  - 1. NEMA ICS 18 - Industrial Control and Systems: Motor Control Centers
  - 2. UL 845 - UL Standard for Safety for Motor Control Centers  
NOTE: UL 845 is a harmonized standard consisting of:
    - a) Underwriters Laboratories Inc. (UL) UL 845
    - b) Canadian Standards Association (CSA) C22.2 No. 254-05
    - c) Association of Standardization and Certification (ANCE) NMJ-J-353-ANCE-2006
  - 3. NFPA 70 - National Electrical Code
- B. The MCC shall be designed, manufactured, and tested in facilities registered to ISO 9001.

#### 1.04 DESIGN REQUIREMENTS

- A. Provide MCC based on applicable NEMA and UL standards and in accordance with the detailed contract specifications and drawings.
- B. The manufacturer of the MCC shall also be the manufacturer of the across-the-line motor starters, across-the-line contactors, solid-state reduced voltage starters, and variable frequency drives. The use of third-party supply and assembly for these components in the motor control center is not acceptable and will be rejected.
- C. The contractor shall confirm motor full-load amperage ratings and provide those ratings to the MCC manufacturer to achieve proper sizing of the motor branch circuit and overload protection.

#### 1.05 PRE-MANUFACTURE SUBMITTALS

- A. Refer to previous sections for submittal procedures.
- B. Manufacturer Drawings.
  - 1. MCC elevations showing dimensional information including details such as, but not limited to, the following:
    - a) MCC height (less any removable lifting angles or eyes)
    - b) MCC width
    - c) MCC depth
    - d) Location of shipping splits
  - 2. Structure descriptions showing the following:
    - a) Bus ratings
    - b) Enclosure ratings
    - c) Short-circuit withstand ratings
    - d) Other information as required for approval
  - 3. Conduit locations
  - 4. Required bus splices
  - 5. Unit descriptions including information such as, starter sizes, circuit breaker frame sizes, circuit-breaker continuous ampere ratings, and pilot devices
  - 6. Nameplate information
  - 7. Schematic wiring diagrams
  - 8. Manufacturer drawings shall be provided in PDF format
  - 9. Manufacturer drawings do not need to be stamped if a drawing schedule is provided that lists the drawing numbers, version levels, and status of drawings (such as, preliminary, approval, and final)

C. Product Data.

1. Data sheets and publications on all major components including, but not limited to, the following:
  - a) Motor starters
  - b) Overload relays
  - c) Circuit breaker and fuse information including time current characteristics
  - d) Control power transformers
  - e) Pilot devices
  - f) Relays
  - g) Variable Frequency Drives

D. Specification Response.

1. All clarifications and exceptions must be clearly identified

E. Installation Instructions.

1. Provide a copy of the manufacturer's installation instructions that includes the following:
  - a) Receiving, handling, and storage instructions
  - b) General description for reading nameplate data, serial numbers, UL markings, and short circuit ratings
  - c) Installation procedures including splicing procedures
  - d) Conduit and cable installation
  - e) Installing and removing plug-in units
  - f) Operation of operator handles and unit interlocks
  - g) Checklist before energizing
  - h) Procedure for energizing equipment
  - i) Maintenance procedures

1.06 FINAL SUBMITTALS

- A. Refer to previous Sections for the procedure on submittal of final documentation.
- B. The contractor shall provide certification that the MCC has been installed in accordance with the manufacturer's instructions and with local codes and standards that govern MCC installations.
- C. The contractor shall provide certification that all circuit breaker settings have been adjusted per field requirements.
- D. The contractor shall provide certification that all power fuses have been selected and installed per field requirements.
- E. The contractor shall provide certification that all solid-state motor overload settings have been adjusted per installed motor characteristics.



- F. The contractor shall provide certification that all settings for solid state devices such as reduced voltage solid-state controllers and variable frequency drives have been adjusted per the specific application requirements.
- G. The contractor shall provide certification that any timing devices have been properly adjusted.
- H. Final Drawings.
  - 1. The manufacturer shall provide final drawings reflecting the 'As-Shipped' state of the MCC documents previously submitted
  - 2. Manufacturer drawings shall be provided in PDF format
  - 3. Manufacturer drawings do not need to be stamped if a drawing schedule is provided that lists the drawing numbers, version levels, and status of drawings (such as, Preliminary, Approval, Final)
  - 4. The contractor shall be responsible for making any changes to the 'as-shipped' drawings from the manufacturer to reflect any field modifications
- I. Test reports indicating manufacturer's standard testing was performed.
- J. Maintenance Data.
  - 1. MCC installation instructions
  - 2. Installation/operation instructions for major components such as, automatic transfer switch and circuit breakers
  - 3. MCC spare parts listing and pricing

#### **1.07 QUALITY ASSURANCE**

- A. The manufacturer of the MCC shall have a minimum of 35-years experience in the manufacturing and assembly of NEMA Low Voltage motor control centers.
- B. The manufacturer shall have ISO 9001 registered facilities for the design, manufacture, and testing of MCCs.
- C. MCC sections and individual MCC units shall be designed and manufactured in accordance with UL 845 requirements.
- D. MCC sections and individual MCC units shall be UL listed, where possible.

#### **1.08 REGULATORY REQUIREMENTS**

- A. Contractor shall ensure that the installation conforms to the requirements of the latest edition of the NFPA 70 'National Electrical Code' and/or other applicable installation standards.

#### **1.09 DELIVERY, STORAGE, AND HANDLING**

- A. The contractor shall coordinate the shipping splits with the MCC manufacturer for entry into the building.
- B. Shipping splits shall be noted on the MCC manufacturer drawings.
- C. The contractor shall store the MCCs in a clean, dry, and heated space.

- D. The contractor shall protect the units from dirt, water, construction debris, and traffic.
- E. During storage the contractor shall connect internal space heaters (if specified) with temporary power.
- F. MCCs are to be shipped with external lifting angles at the top and running continuously for each shipping split. Lifting eyelets are not acceptable.

#### **1.10 ENVIRONMENTAL REQUIREMENTS**

- A. The MCC enclosure rating shall be appropriate for the environment where the MCC is to be located.

#### **1.11 FIELD MEASUREMENTS**

- A. The contractor shall verify all field measurements prior to the fabrication of the MCC.

#### **1.12 WARRANTY**

- A. The manufacturer shall provide their standard parts warranty for 12 months from the date of invoice.
- B. The manufacturer shall confirm this warranty as part of the submittal.

#### **1.13 SPARE MATERIALS**

- A. The contractor shall review the manufacturer's recommended spare parts list and discuss it with the owner to determine requirements for spare parts.
- B. The contractor is to provide the quotation for spare parts to the owner.

### **PART 2 – PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. MCCs shall be Allen-Bradley® CENTERLINE® 2100 motor control centers or equal.

#### **2.02 RATINGS**

- A. The MCC shall be rated for the system voltage as indicated on the contract drawings.
- B. The MCC horizontal and vertical power bus bracing shall be rated to meet or exceed the available fault current as shown on the contract drawings, but shall not be less than 42,000 A rms symmetrical.
- C. All MCC units shall have a full rated short-circuit rating that meets or exceeds the available fault current as shown on the contract drawings.
  - 1. The use of series short-circuit ratings shall be permitted only for panelboards; series short-circuit ratings for other types of units is not acceptable

- D. All circuit breakers used in the motor control center shall have full-rated short-circuit interrupting ratings based on the applied MCC voltage.
  - 1. Slash rated short-circuit interrupting ratings for circuit breakers are not acceptable except for branch circuit breakers in panelboards, and then only if the power system specified in the contract drawings is a Wye with a solidly grounded neutral

## 2.03 ENCLOSURE

- A. The MCC enclosure shall be NEMA Type 1 with gasket around perimeter of doors.
- B. Each section shall be equipped with two full-metal side sheets to isolate each vertical section and to help reduce the likelihood of fault propagation between sections.
- C. All interior and exterior surfaces shall be painted ANSI 49 medium-light gray. The vertical wireways and unit back plates shall be painted high-visibility gloss white.
- D. All unpainted parts shall be plated for corrosion resistance.
- E. Removable closing plates on each end of the MCC shall cover all horizontal bus and horizontal wireway openings.

## 2.04 STRUCTURE

- A. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.
- B. Vertical sections shall be rigid, free-standing structures.
  - 1. Vertical sections shall have internal mounting angles running continuously within the shipping block
  - 2. An external mounting channel that is required to maintain structure integrity is not acceptable
  - 3. Vertical sections shall be 90 in. high, 20 in. deep and 20 in. Wide, except where larger dimensions are required
  - 4. 71 in. high, reduced height sections shall be provided, if specified on the contract drawings
  - 5. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block
  - 6. Lifting eyes are not acceptable
  - 7. Each standard section shall be capable of being subdivided into 12 usable, unit spaces
  - 8. Two unit spaces shall constitute one space factor and shall be 13 in. in height
  - 9. One unit space shall constitute one-half space factor and shall be 6.5 in. in height
- C. Horizontal wireways.
  - 1. Horizontal wireways shall be located at the top and bottom of the MCC
  - 2. Horizontal wireways shall be 6 in. in height and extend the full depth of the vertical section to allow maximum flexibility in locating conduit for MCC feeds and loads

- a) Pull-boxes to extend the height of the top horizontal wireway by 12 in. shall be provided, if specified on the contract drawings
- 3. Horizontal wireways shall be continuous across the length of the MCC, except where access needs to be denied due to electrical isolation requirements
- 4. The horizontal wireways shall be isolated from the power bus
- 5. The horizontal wireways shall have removable covers held in place by captive screws
- D. Provide a full height vertical wireway, independent of the plug-in units, in each standard vertical section.
  - 1. The vertical wireway shall be isolated from the vertical and horizontal buses
  - 2. The vertical wireway shall be covered with a hinged and secured door
  - 3. Wireway tie bars shall be provided
  - 4. Isolation between the wireway and units shall be provided

## **2.05 BUS BARS**

### **A. Horizontal Power Bus.**

- 1. The horizontal bus shall be rated as shown on the drawings
- 2. The horizontal bus material shall be copper with tin plating
- 3. The horizontal bus shall be supported, braced and isolated from the vertical bus with a high strength, non-conductive, non-tracking, glass polyester material
- 4. For standard sections, the horizontal bus shall be continuous within each shipping block and shall be braced within each section
- 5. Horizontal bus splices shall have at least two bolts on each side

### **B. Vertical Bus.**

- 1. The vertical power bus shall have an effective rating of 600 A. If a center horizontal bus construction is utilized, then the rating shall be 300 A above and below the horizontal bus for an effective rating of 600 A. If a top or bottom mounted horizontal bus is utilized, then the full bus must be rated for 600 A
- 2. The vertical bus material shall be copper with tin plating
- 3. The vertical bus shall attach to the horizontal bus with at least two bolts
- 4. The vertical bus shall be continuously braced by a high strength, non-conductive, non-tracking, glass-filled polyester material and isolated from the unit spaces by a non-conductive, polycarbonate molded cover
- 5. The vertical bus shall be isolated from the horizontal power bus except where necessary to connect the vertical power bus to the horizontal power bus
- 6. Automatic shutters shall cover plug-in stab openings when units are removed

### **C. Ground Bus.**

- 1. Provide a ground bus system consisting of a horizontal ground bus connected to vertical ground buses mounted in each section
- 2. Provide an tin-plated copper 0.25 x 2 in. horizontal ground bus mounted in the bottom of the MCC unless otherwise specified in the drawings
- 3. Provide a pressure-type mechanical lug mounted on the ground bus in the incoming line section

4. Provide a unit ground stab on all unit inserts. The ground stab shall establish unit insert grounding to the vertical ground bus before the plug-in power stabs engage the power bus. The grounding shall be maintained until after the plug-in power stabs are disengaged

D. Neutral Bus.

1. In a 4-wire system with a main incoming device rated 400 A or less, if there are no neutral loads in the MCC, an incoming neutral termination plate in the MCC main device unit is acceptable in lieu of a horizontal neutral bus
2. In a 4-wire system with a main incoming device rated more than 400 A, if there are no neutral loads in the MCC, an incoming neutral termination plate in the MCC main device unit that is connected to horizontal neutral bus in the section with the main is acceptable
3. If neutral loads are specified within the MCC, provide neutral connection plates in sections with horizontal neutral bus as indicated on the contract drawings
4. Horizontal neutral bus shall be provided all sections
5. Neutral bus rating shall be the same as the horizontal power bus rating

## 2.08 UNIT INFORMATION

- A. The minimum compartment height shall be 6.5 in. and this shall be considered one-half space factor.
- B. NEMA Size 5 FVNR starters and below shall be provided as plug-in units.
- C. Plug-in units.
  1. Plug-in units shall consist of a unit assembly, unit support pan, and unit door assembly
  2. Units shall be supplied with removable doors. The unit doors shall be fastened to the structure so that the doors can be closed when the unit is removed
  3. A unit support pan shall be provided for support and guiding units. Unit support pans shall remain in the structure when units are removed to provide isolation between units
  4. A service position shall be provided for plug-in units that allows for the unit to be supported, but disengaged from the bus. The unit shall be capable of being padlocked in the service position. This position is to be used to isolate a unit from the bus to allow service to be performed on the connected load equipment

## D. Power Stabs.

1. Unit stabs for engaging the power bus shall be tin-plated copper and provided with stainless back-up springs to provide and maintain a high pressure 4-point connection to the vertical bus
2. Wiring from the unit disconnecting means to the plug-in stabs shall not be exposed on the rear of the unit. A separate isolated pathway shall be provided for each phase to minimize the possibility of unit fault conditions reaching the power bus system
3. Power cable termination at the plug-in stab shall be a maintenance-free crimp type connection

## E. Withdrawable Power Stabs.

1. Plug-in units shall have the capacity of withdrawing the power stabs, allowing the primary voltage to be disconnected with the unit door closed
2. The withdrawable assembly shall accept a standard 1/4' hex-style drive socket
  - a) A complete power engagement shall occur when turning the mechanism ¼ turn in clockwise direction
  - b) Complete power disengagement shall occur when turning the mechanism ¼ turn in counter-clockwise direction
3. The withdrawable stabs design shall include a set of stab assembly-mounted shutters
  - a) shutters shall automatically open before the power stabs can extend and connect to the vertical bus
  - b) shutters shall close as soon as the power stabs are disconnected from the vertical bus and are completely inside the stab housing
4. The withdrawable stabs design shall include interlock mechanisms
  - a) A through-the-door mechanism shall allow the unit to be locked in the 'Power Stabs Disconnected' position
    - i. This mechanism shall be such that it can be padlocked to prevent the connection of the stabs to the vertical bus even when the unit is inserted into the vertical section
    - ii. Unit door shall be capable of opening with the padlock and lockout engaged
  - b) Unit disconnect handle must be in the OFF position (load side of the disconnect device removed from line power) before the stabs can be disconnected from the vertical bus
    - i. Mechanism shall also allow the removal of the unit from the vertical section but only after the disconnect handle has been turned OFF and the power stabs have been disconnected from the vertical bus
    - ii. Unit stabs have to be disconnected (withdrawn) before the unit can be re-inserted into the vertical section

5. The withdrawable stabs design shall include feedback mechanisms that are verifiable with the unit door closed
  - a) A two-position indication system shall be provided (Power Stabs Connected/Disconnected) and shall be visible from the door
    - i. Connected with Red Indication—Primary voltage stabs fully engaged and connected to the vertical bus
    - ii. Disconnected with Green Indication—Primary voltage stabs fully disconnected from the vertical bus
  - b) A set of test points shall be located on the front of the unit for identification of:
    - i. Power stabs position: a positive continuity check between these probes shall verify that all three power stabs have been disconnected from the vertical bus and completely withdrawn inside the stabs housing
    - ii. Stab-mounted shutters position: a positive continuity check between these probes shall verify that the shutters are closed, meaning that all three power stabs have been disconnected and withdrawn inside the stab housing
6. Withdrawable power stabs with door closed mechanism shall not increase the original unit height design so total space in the motor control center is optimized
7. A remote operating device shall be supplied to allow the connection and disconnection of the power stabs with the door closed
  - a) The minimum distance shall be not less than three times the minimum default value recommended by the NFPA 70E (Arc Flash Protection Boundary—Annex D)

F. Disconnect Handle.

1. Plug-in units shall be provided with a heavy-duty, non-conductive, industrial duty, flange mounted handle mechanism for control of each disconnect switch or circuit breaker
2. Use of rotary operators is not acceptable
3. Disconnect handles may pivot in the vertical or horizontal plane
4. On-off condition shall be indicated by the handle position, red and green color indicators with the words ON and OFF, and the international symbols 1 and O along with a pictorial indication of the handle position
5. Handles shall be capable of being locked in the OFF position with up to three padlocks
6. Plug-in units shall be provided with interlocks per NEMA and UL requirements. Interlocks shall be provided for the following:
  - a) Prevention of unit insertion or withdrawal with the disconnect in the ON position
  - b) Prevention of the unit door from being opened when the disconnect is in the ON position
    - i. A feature for intentionally defeating this interlock by qualified personnel shall be provided

- c) Prevention of the disconnect switch from being moved to the ON position if the unit door is open
  - i. A feature for intentionally defeating this interlock by qualified personnel shall be provided

G. Pilot Devices.

- 1. Pilot devices required in each FVNR starter or VFD section include:
  - a. Running lights (red)
  - b. Stop lights (green)
  - c. Hand-Off-Auto 3-position maintained switches with auxiliary contact blocks for "In Auto" position wired to terminals
- 2. Pilot devices shall be rated NEMA Type 4/13 water tight/oil tight
- 3. For units with vertically operated disconnect handles:
  - a) When three or less pilot devices are utilized, they shall be Allen-Bradley Bulletin 800T or 800H 30.5mm devices or approved equal
  - b) When more than three devices are required, the use of Allen-Bradley Bulletin 800F 22.5mm devices (or approved equal) is permitted
- 4. For units with horizontally operated disconnect handles:
  - a) The devices shall be Allen-Bradley Bulletin 800F

H. Terminal Blocks.

- 1. Control terminal blocks shall be provided on all contactor and starter units.
  - a) Control terminal blocks shall be a pull-apart design on all plug-in units for easy removal of the unit from the structure
- 2. Control terminal blocks on non-plug-in contactor and starter units shall be fixed type.
- 3. Power terminal blocks shall be provided on all contactor and starter units, rated NEMA size 3 (100 A) and below that utilize vertically operated disconnects
  - a) Power terminal blocks shall be pull-apart for NEMA size 1 and 2 (30 A and 60 A contactors)
  - b) Power terminal blocks for NEMA size 3 starters (100 A contactors) shall be non-pull-apart
- 4. Terminal blocks shall not be located adjacent to or inside the vertical wireway

I. Doors.

- 1. Each unit shall be provided with a removable door mounted on removable pin-type hinges
- 2. The unit doors shall be capable of being opened at least 110 degrees
- 3. The unit doors shall be removable from any location in the MCC without disturbing any other unit doors
- 4. The unit door shall be fastened to the structure so it can be closed to cover the unit space when the unit is removed
- 5. The unit doors shall be held closed with quarter-turn latches



## 2.09 METERING COMPARTMENT

- A. MCCs shall include a plug-in metering unit.
- B. Units shall include the following.
  - 1. Fusible disconnect with fuses
    - a) The disconnect must be operable with the unit door closed
  - 2. Fused control circuit transformer
  - 3. Current transformers shipped loose to be installed by the contractor onto incoming power conductors
  - 4. Solid-state power monitor with door mounted display
- C. Power Monitor.
  - 1. Power monitors shall be capable of displaying the following:
    - a) Line current for all three phases with plus or minus 0.2 percent full-scale accuracy
    - b) Average three phase current with plus or minus 0.2 percent full-scale accuracy
    - c) Line-to-neutral and line-to-line voltage with plus or minus 0.2 percent of full-scale accuracy
    - d) Current and voltage unbalance
    - e) Real, reactive, apparent, and true power with plus or minus 0.4 percent full-scale accuracy
    - f) KWh, KVARh, and kVAHnet
    - g) True RMS to the 45th harmonic
    - h) Frequency at plus or minus 0.5%
    - i) Power factor at plus or minus 0.4%
  - 2. Power monitors shall include min/max logs and trend logs with up to 45,867 data points
  - 3. Power monitors shall be capable of performing distortion analysis with THD, Crest Factor (I, V) and Distortion power factor
  - 4. The power monitor shall include an EtherNet/IP communication port as standard and shall include no additional communication capability
  - 5. Power monitors shall include two form-C relays
  - 6. Power monitors shall be Allen-Bradley PowerMonitor™ 5000 unit or approved equal

## 2.10 DISCONNECTS

- A. Main Disconnect.
  - 1. If no overcurrent protection is indicated, provide a main incoming-line lug compartment
    - a) Lugs to accommodate the incoming power conductors as indicated on the contract drawings shall be provided by MCC Manufacturer

2. Main Fusible Disconnect Switch (if specified in contract drawings)
  - a) Lugs to accommodate the incoming power conductors as indicated on the contract drawings shall be provided by the MCC manufacturer
  - b) Power fuses to be provided by MCC manufacturer
  - c) Size fuses as shown on the drawings. Provide Class J fuses through 600 A. Provide Class L fuses above 600 A
  - d) Provide a removable protective barrier to reduce the possibility of contact with the line terminals
  - e) Provide one normally open and one normally closed auxiliary contact
3. Main Circuit Breaker Disconnect (if specified in contract drawings)
  - a) Lugs to accommodate the incoming power conductors as indicated on the contract drawings shall be provided by the MCC manufacturer
  - b) Size the circuit breaker frame and trip rating as shown on the drawings
  - c) The interrupting capacity rating shall meet or exceed the available fault current as shown on the contract drawings. Interrupting capacity based on a slash rating is not acceptable
  - d) Provide a circuit breaker with thermal magnetic trip unit for 250 A and smaller frames; provide electronic trip unit for 400 A and larger frames
  - e) Provide a removable protective barrier to reduce the possibility of incidental contact with the line terminals
  - f) Provide one normally open and one normally closed circuit breaker auxiliary contact that follows the position of the circuit breaker main contacts for indication of 'On' or 'Off/Tripped'
  - g) For circuit breakers rated 1000 A and above, on Wye connected systems with a solidly grounded neutral, provide integrated ground fault protection with adjustable pick-up and adjustable time delay

**B. Feeder Disconnects**

1. Disconnecting means for feeders shall be circuit breakers with thermal-magnetic trip units for 250 A and smaller frames; provide an electronic trip unit for 400 A and larger frames
2. Interrupting capacity rating shall meet or exceed the available fault current as shown on the contract drawings. Interrupting capacity based on a slash rating is not acceptable
3. Minimum frame size shall be 125 A
4. Provide one normally open and one normally closed circuit breaker auxiliary contact which follows the position of the circuit breaker main contacts for indication of 'On' or 'Off/Tripped'

## 2.11 COMBINATION NEMA ACROSS THE LINE STARTERS

- A. Starters shall meet applicable NEMA and UL requirements.
- B. Starters shall be minimum NEMA Size 1.
  - 1. Fractional NEMA sizes are not acceptable
- C. The motor starter shall be Allen-Bradley Bulletin 500 or 300 or approved equal.
- D. Starters shall be provided with a 3-pole solid state overload relay that includes the following features:
  - 1.. Selectable trip classes of 10, 15, 20, or 30
  - 2. Set for class 20 unless otherwise indicated on the contract drawings
  - 3. Overload protection
  - 4. Phase loss protection
  - 5. Trip current adjustment range of 5:1
  - 6. Visual trip status indication
  - 7. Test/Reset button
  - 8. Bipolar latching relay with one normally open and one normally closed contact, rated NEMA B600 for use in motor contactor control circuits
  - 9. Thermal memory circuit to model the heating and cooling effects of motor on and off periods
  - 10. The overload relay shall be Allen-Bradley 193-EE or 592-EE 'E1 Plus'
- E. In addition to the hold-in contact, starters shall be provided with one normally open and one normally closed auxiliary contact. The starter shall be capable of accommodating up to six contact in addition to the hold-in contact.
- F. Provide a control power transformer with a rated secondary voltage of 120V AC. The control power transformer shall be provided with primary and secondary fusing.
- G. Overload relays shall have a reset button located on the outside of the unit door.
- H. The overload relays shall contain an auxiliary dry contact, wired to terminals for connection to the SCADA system for alarm notification
- I. In addition to overload contacts wired to terminals for SCADA system monitoring, motor starter auxiliary contacts for "run" monitoring shall be wired to terminals

## 2.12 MOTOR STARTER UNITS.

- A. Electro-mechanical NEMA starters:
  - 1. Disconnecting means for the across the line starters shall be motor circuit protectors
  - 2. unit short circuit rating shall be greater than or equal to the available fault current as shown on the contract drawings
  - 3. Units shall be supplied based upon the rules/requirements set forth in the UL 845, NEMA ICS-18, and NFPA 70
  - 4. Contractor shall field adjust the units based upon the particular motor application.
  - 5. Minimum MCP frame size shall be 125 A
  - 6. Provide one normally open and one normally closed circuit breaker auxiliary contact that follows the position of the circuit breaker main contacts for indication of 'On' or 'Off/Tripped'

## 2.13 VARIABLE FREQUENCY DRIVES

- A. Variable frequency drives shall be Allen-Bradley PowerFlex 753, or equal.
  - 1. Refer to Section 16157 for specifications
- B. Provide a control power transformer with a rated secondary voltage of 120V AC. The control power transformer shall be provided with primary and secondary fusing.
- C. Provide door-mounted pilot devices per the pilot device specification section above.
- D. Provide door-mounted 120V AC pilot lights per the pilot device specification section above.
- E. Provide a door-mounted human interface module for programming, display and control.
- F. Provide two isolated, configurable analog input and output.
- G. Harmonic mitigation, including the Point of Common Coupling (PCC), shall be as indicated on the drawings. MCC-mounted harmonic mitigation elements shall be UL/cUL listed
- H. MCC-mounted Active Harmonic Filters (AHF), as indicated on drawings, shall be furnished for harmonic mitigation of the MCC-connected loads
  - 1. Limit harmonic current to <5% Total Demand Distortion (TDD) per IEEE519-1992, table 10.3
  - 2. AHFs shall be capable of parallel connection of multiple units to meet the required level of mitigation
  - 3. Door-interlocked disconnect shall be furnished
  - 4. Shall include electronic output current limiting and over-temperature protection
  - 5. Current Transformers (CTs) shall be supplied for field installation on the MCC incoming power cabling
  - 6. Operator interface shall be via LCD touchscreen for ON, OFF, parameter configuration and display of power quality, operational status and parameter settings
  - 7. Relay contacts wired to terminals shall be provided for "On" (Running) and "Fault" conditions
  - 8. Communication capabilities shall include RS232 and Ethernet/IP

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Contractor shall install MCC in accordance with manufacturer's instructions.
- B. Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer's torque requirements.
- C. Contractor shall select and install fuses in fusible switches based upon field requirements.
- D. Contractor shall adjust circuit breaker settings based upon field requirements.

E. Contractor shall adjust solid state overloads to match the installed motor characteristics.

**3.02 MANUFACTURER'S SERVICES**

- A. Manufacturer of the MCC shall be capable of providing the programming for the programmable logic controller and the operator interface if provided within the MCC.
- B. Manufacturer of the MCC shall be capable of providing start-up services as part of the supply of the MCC.

**3.03 TRAINING**

- A. A course outline shall be submitted as part of the MCC submittals.

End of section.





Preliminary Geotechnical Report  
for  
**Greenup Water Filtration Plant**

Greenup, Greenup County, Kentucky

May 3, 2017

Prepared for

**Howerton Engineering & Surveying**

Greenup, Kentucky

CSI Project Number CN170040

[csikentucky.com](http://csikentucky.com) | [csiohio.com](http://csiohio.com)

858 Contract Street, Lexington, Kentucky 40505 | 11012 Decimal Drive, Louisville, Kentucky 40299

11162 Luschek Avenue, Cincinnati, Ohio 45241





## Consulting Services Incorporated

Lexington 859.309.6021 | Cincinnati 513.252.2059 | Louisville 502.532.8269  
Geotechnical & Materials Engineering | IBC Special Inspection | Material Testing

May 3, 2017

Richard Howerton  
Howerton Engineering & Surveying  
404 Main Street  
Greenup, Kentucky 41144

Subject: **Preliminary Geotechnical Investigation**  
**Greenup Water Filtration Plant**  
**Greenup, Greenup County, Kentucky**  
**CSI Project Number CN170040**

Dear Mr. Howerton:

**Consulting Services Incorporated Cincinnati (CSI Cincinnati)** is pleased to present our preliminary report for the geotechnical services for the proposed water filtration plant. We provided our services in general accordance with the CSI Proposal Number 4633, dated September 21, 2016.

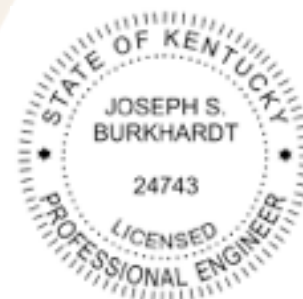
Our report represents information provided to us, readily available published data relevant to the site and site area, our observations and subsurface conditions encountered and our opinion of primary geotechnical conditions (discussion and recommendations) affecting design, construction and performance of the proposed earth-supported portions of the project.

We appreciate the opportunity to provide our geotechnical services to you and the design team. Please do not hesitate to contact us for questions or comments about the information contained herein.

Sincerely,

Graham T. Duncan, E.I.T.  
Staff Engineer

Joseph S. Burkhardt, P.E.  
Principal Engineer



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	Test Boring Records
	Field Testing Procedures
	Summary of Soil Laboratory Tests
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## INTRODUCTION

### 1 SCOPE OF THE GEOTECHNICAL EXPLORATION

As outlined in our proposal, CSI conducted a preliminary geotechnical exploration for the proposed water filtration plant in Greenup, Kentucky. Our services included a review of the project information provided, conducting a subsurface exploration that utilized soil borings to obtain samples for modeling the soil conditions at the subject site, an analysis of the data and information obtained, providing recommendations for foundations associated with the new structure(s), along with earthwork recommendations to aid in the development of the site.

Project information was provided by Howerton Engineering & Surveying during the proposal and project phase of the project. CSI was provided with a drawing outlining the locations for the water filtration and lagoon structures titled 'Proposed Water Filtration Plant and Raw Water Intake' dated September 2016. As indicated below, the orientation of the lagoon structure has been rotated from the previous location.

Our geotechnical services provided, while yielding design recommendations, are general in terms of the amount of information provided to us and the level of exploration performed. CSI should be retained to provide continued services for the construction phase of the project and to review final plans for compliance with this report.

### 2 SITE AND PROJECT INFORMATION

As indicated, a new water filtration plant is planned in Greenup, Kentucky south of the intersection of US 23 and KY Route 2.

Table 1: Project Information

Item	Description
Site Layout	See Boring Location Plan in Appendix. Boring B-1 was relocated from the hillside to the west of the site and placed within the gravel entrance northeast of the existing home after speaking with Jami Salisbury of Howerton Engineering and Surveying and being informed that the orientation of the lagoon had been rotated. After speaking with Jami Salisbury of Howerton Engineering and Surveying, Boring B-1, which was planned along the hillside was designated as a Hand Auger Boring and Boring B-9 was added to address the new orientation of the Lagoon that was discussed. The Lagoon structure is now rotated about 90 degrees and is will be located at the base of the hillside.
Proposed Structure(s)	A single structure with several below grade clear wells which will be extended to depths of 12 to 15 feet below grade and a lagoon which is assumed to be approximately 10 to 15 feet deep. We have assumed a small portion near B-7 will be at grade
Structure Footprint	The clear well building will occupy an approximately 10,000 ft <sup>2</sup> footprint while the lagoon be approximately 10,500 ft <sup>2</sup> .
Building Construction	Cast-in-place concrete and structural steel supported on a mat foundation
Finished Floor Elevation (FFE)	Finished Floor Elevation has been assumed to be 12 to 15 feet below grade (bottom of structure), with an assumed top of wall elevation of 546 feet (about 1 to 2 feet above existing grades)
Maximum loads	Mat Foundation (main structure): 2,000 psf or less (assumed) Continuous Foundations (entrance/office): 2 kips per linear foot
Proposed Grading	Cuts of up to 15 feet are associated with both the clear well excavations and lagoon. Fill on the site is assumed to be less than 2 feet

**Table 2: Site Information**

Item	Description
Site Location	The site is located just south of the intersection of US 23 and KY Route 2
Size of Site	Approximately 1.3 acres
Surrounding Area	The surrounding area is residential and light commercial. The Little Sandy River and Ohio River are also located less than one half mile to the northwest and northeast, respectively
Existing Ground Conditions	The site is largely paved with asphalt with areas to the south of the site being grass covered. A wooded hillside is present on the south western portion of the site
Existing Structure(s)	A large metal garage type structure and a smaller home are also located on the south western portion of the site.
Existing Utilities	Gas lines were located along KY Route 2 as well as overhead power lines. Other utilities are unknown.
Previous Site Use	The site appears to have been used recently as a storage yard for various vehicles, trailers, and portable storage units. In addition several vehicle frames and parts were observed to the south of the site near the existing metal garage structure. In review of the geologic map of the project site, it appears that several homes may have previously been present on the site.

### 3 AREA/SITE INFORMATION

#### 3A AREA TOPOGRAPHY/PHYSIOGRAPHY

The site is located within the Eastern Kentucky Coal Field which is part of a larger physiographic region called the Cumberland Plateau (which extends from Pennsylvania to Alabama). This region is known for coal mining with bedrock being comprised primarily of sandstone and shale.



**Figure 1 - Kentucky Physiographic Map (site vicinity shown with star)**



### 3B SITE GEOLOGY

Published geologic mapping provided by the Kentucky Geological Survey indicates the site is underlain by Quaternary-aged alluvial deposits. These deposits are primarily comprised of unconsolidated sand, silt and gravel from flood-plain deposits associated with the Ohio River. Directly to the south east along the hillside (partially located on the project site), bedrock is associated with the Breathitt Group. This formation consists of shale, siltstone, and sandstone.



Figure 2: Kentucky Geological Survey Online Mapping (site location outlined)

### 3C PUBLISHED SITE SOIL CONDITIONS

Review of the soil survey of Greenup County indicates the site is primarily associated with well-drained soils associated with stream terraces that have a moderate to high capacity to transmit water. Along the slope some colluvial soils are mapped. The table below summarizes each of the soil units.

[INTENTIONALLY LEFT BLANK]



**Table 3: USDA Soil Survey**

Soil Series	Abbreviation	Slope (%)	Parent Material	Percentage of Site (%)	Depth to Restrictive Feature (in.)	Depth to Water Table (in.)
Otwell Silt Loam	OtA	0 to 2	Fine-silty alluvium	73.0	20 to 36	18 to 30
Weinbach Silt Loam	WB	0 to 2	Fine-silty alluvium	23.0	18 to 28	12 to 18
Shelocta Gravely Silt Loam	ScC	6 to 12	Fine-loamy alluvium	3.5	>80	>80
Latham-Shelocta Silt Loams	LsF	30 to 50	Clayey-Colluvium	0.5	20 to 40	18 to 24



**Figure 3 - USDA Soil Survey Map of Project Site**

### 3D AERIAL PHOTOGRAPHS (Google Earth)

Review of the historical aerial photos from 1995 indicates the site has seen little to no development. A small building was constructed to the north west of the site between 1995 and 2004. No other discernible changes are observed since 2004.



Figure 4 - Google Earth 3/13/1995



Figure 5 - Google Earth 9/21/2016





## 4 SITE PHOTOS



Photo 1: Looking north west towards KY-2



Photo 2: Looking south west towards existing home



Photo 3: Looking south west towards metal structure and vehicles



Photo 3: Looking north east towards US 23

## FINDINGS

### 5 SUBSURFACE CONDITIONS

A total of eight (8) conventional soil test borings were performed to explore the subsurface conditions at the site as well as one hand auger boring (B-1) located on the hillside. In general, previously placed fill was encountered overlying alluvial soils and residuum in all boring locations.

#### 5A STRATA INFORMATION

The subsurface conditions encountered at the boring locations are shown on the Test Boring Records in the Appendix. These Test Boring Records represent our interpretation of the subsurface conditions based on the field logs, visual examination of field samples by an engineer, and tests of the samples collected. The letters in parentheses following the soil descriptions are the soil classifications in accordance with the Unified Soil Classification System. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths.



## **SURFICIAL COVER**

Asphalt pavement was present in the general area of borings B-2, B-3, B-5, B-7, and B-8 and was measured to be between 2 and 5 inches thick overlying an approximately 5 to 9 inch thick layer of gravel base. Topsoil was present at the remaining borings locations and was noted to be between 2 and 4 inches thick.

## **FILL**

What appeared to be previously placed fill material was encountered underlying the gravel base/topsoil in each boring location and was noted to range between about 3 to 8 feet thick, but was measured to be about 5.5 feet thick in most boring locations. The fill was described to be brown to dark brown lean clay with trace roots, varying amounts of rock fragments, and silt. Standard Penetration Test (SPT) N-values ranged from 3 to 10 blows per foot (bpf) indicating a soft to stiff consistency. Natural moisture contents ranged from about 6.7 to 25.5 percent.

## **ALLUVIAL SOILS**

Alluvial soil deposits consisting of clay, silt, and/or sand layers were encountered underlying the fill in each boring location. The alluvial soils were described primarily as brown to brown and gray mottled lean clay with silt and varying amounts of sand. Silt strata were observed in Borings B-3 and B-8 at depths of 15 and 22 feet, respectively. Several samples (B-9, B-6, and B-8) also encountered fine grained sands and gravel near termination depths (12 feet in boring B-9 and 27 feet in borings B-6 and B-8). SPT N-values within the cohesive soils ranged from 3 to 13 bpf indicating a soft to stiff consistency, while SPT N-values within the granular materials ranged from 6 to 30 indicating a loose to very firm relative density. It should be noted that the alluvial soils sampled became noticeably softer after encountering groundwater. Laboratory index testing of several samples indicates Liquid Limits ranging from 40 to 47 percent and Plasticity Indices of 19 percent. Natural moistures ranged from 14.2 to 29.7 percent.

## **COLLUVIAL SOILS**

One hand auger boring (B-1) was completed on the hillside along the south eastern portion of the site and encountered colluvial soils. The soils were described as brown lean clay with varying amounts of shale fragments and silt.

## **WEATHERED BEDROCK**

Highly weathered sandstone was sampled in boring B-4 at depths of about 17 feet below grade. In addition boring B-2 encountered brown to gray highly weathered and thinly laminated shale at a depth of about 12 feet below grade.

## **5B GROUNDWATER CONDITIONS**

Groundwater was encountered in each boring with the exception of borings B-7 and B-1 at depths ranging from about 8 feet to 24.5. A temporary groundwater monitoring well was also installed at B-4 for future measurements if needed. Based on published information, the static water level elevation of the Ohio River is 515 feet. At the time of drilling, the level of the river fluctuated from about 515 to 516 feet (March 31, 2017 to April 4, 2017). Given that site's proximity to the two rivers, that static water table would be close to this elevation and would fluctuate with respect to their height. The groundwater observed in Borings B-5 and B-6 where the water elevation was around 517 to 519 feet is most likely associated with the static water level. Groundwater encountered in the remaining borings would be associated with perched groundwater within the fill, silt, and sand strata. Perched water sources are erratic with highly variable





seepage rates and difficult to predict. Site excavations activities and other ground disturbance can expose these water sources resulting in unstable slopes/excavations, water control issues, and soften of soils. Both perched and static sources are dependent upon recent rainfall activity and subsurface drainage patterns.

## **6 LABORATORY AND FIELD TESTING**

### **6A LABORATORY TESTING - GEOTECHNICAL**

Laboratory tests were performed on selected recovered samples from our borings. Details for the test methods and results are shown in the appendix. The tests include obtaining data for estimating soil shear strengths, and compressibility, and to provide data for earthworks. Detailed descriptions of these tests and the results of our testing are included in the appendix. Tests performed included:

- 30 Natural moisture content tests
  - Moisture contents ranged from 6.7 to 29.1 percent
- 4 Atterberg Limit Test
  - Liquid Limits ranging from 40 to 47 percent with Plasticity Indices of 19 percent
- 4 Grain Size Analysis
  - Percentage of material passing #200 Sieve ranged from 87 to 90 percent

## **GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS**

### **7 DISCUSSION-GEOTECHNICAL ISSUES**

Based on our experience with similar projects and the conditions observed during our subsurface exploration, we believe the site is suitable for the proposed development. The primary geotechnical concerns are:

- UNDOCUMENTED FILL MATERIALS
- DEMOLITION OF EXISTING STRUCTURES
- marginally soft alluvial soils
- GROUND WATER AND SIDE WALL STABILITY

#### **7A UNDOCUMENTED FILL MATERIAL**

Undocumented fill was encountered in all of our conventional boring locations to depths of 3 to 8 feet, with the majority of the fill encountered being about 5.5 feet thick. Undocumented fill materials are often improperly compacted, commonly contain organics and debris, and are poor bearing materials. Fills placed in an uncontrolled manner have proven to be problematic. The problems generally arise not from general settlement, but from erratic differential settling of the fill. The settlement of old fill masses is dependent upon several factors such as fill thickness, degree of compaction, fill contents, and age of the fill mass.

While excavation depths associated the clear wells and lagoon structures are anticipated to penetrate the fill material encountered, fill material may be encountered at bearing depths for what we have considered the at grade portion of the structure (near B-7). We recommend that the fill material is undercut from these areas. Specific recommendations are provided below.



## **7B DEMOLITION OF EXISTING STRUCTURES**

Based on our understanding of the project, we understand that the existing metal garage structure and asphalt pavement will be demolished/removed prior to construction. In addition, the home located on the south western portion of the site will also likely be demolished. Our experience has been that constructing over remnants of previous construction or disturbed soils from previous construction poses risks with excessive differential and total settlement due to non-uniform support conditions and possible deleterious materials. Once razed, the construction debris from these areas should be removed from the site. Disturbed soils should also be undercut and evaluated by the geotechnical engineer for potential reuse. If deemed unsuitable, soils should be removed from the site or used in non-structural areas. If determined to be acceptable, the material can be placed as engineered fill in controlled lifts in accordance with Section 8 of this report.

## **7C MARGINALLY SOFT ALLUVIAL SOILS**

As indicated, the each of the borings primarily encountered alluvial soils. These soils can be highly variable due in part as to how they were formed and are considered unconsolidated. It is common to observe cohesive and non-cohesive alternating layers of clay, silt, sand and gravel strata with variable thicknesses. These soils can not only have a soft consistency and be settlement prone, but also present risks with excavation stability and erratic groundwater flow along with being highly sensitive to disturbance

It should be anticipated that some stabilization may be necessary at the bearing elevation of the structure due to the marginally soft soils encountered and the likelihood that disturbance from excavating the materials and other heavy equipment may further soften these soils. The presence of groundwater will also heighten their instability.

## **7D GROUNDWATER AND SIDE WALL STABILITY**

Groundwater was observed in all but one of the boring locations. It is our opinion that the static groundwater level at the site is directly related to the height of the Ohio River (Elev. 515 feet). Several of the borings indicated water levels much shallower than that, which is most likely perched water sources within the fill, silt, and sand strata. As noted, perched groundwater sources are hard to predict not only locations, but flow rates. In addition, when these groundwater sources are exposed in excavation cuts, the groundwater flow can cause instability and significant strength loss of materials resulting in sloughing and/or collapse of excavations.

In evaluating the proposed excavation with respect to nearby structures, consideration for temporary shoring along with alternative pumping systems (beyond conventional sump pumps) may be necessary. In this instance, driven sheet piling could serve as a means to control groundwater and provide stability. For areas where temporary shoring may not be deemed necessary to support surrounding structures, excavations may have to be laid back for stability purposes beyond what would typically be performed or OSHA guidelines. CSI should be contacted if unstable conditions or significant groundwater is encountered.

## **8 EARTHWORK**

Historically, more change orders (in orders and costs) occur during the earthwork portion of construction than in almost any other part of the project. Further, the site preparation phase of construction always affects the future performance of project structures and pavements. Add into this, the fact that earthwork is the portion of work most influenced by wet weather and unknown conditions and time-wise, this section of the report could be the most important to prevent and minimize delays and costs during construction and for the life of the project.



## **8A EXCAVATIONS**

Normal earth excavation equipment should be suitable for necessary cut and fill operations that are associated with the overburden soils. For below-grade excavations, the fill material should be sloped at a minimum of 1.5H:1V. Excavations in alluvial soils should also sloped at a minimum of 1.5H:1V. For areas where groundwater or unstable soils are encountered, flatter slopes may be required. If site constraints are such that below-grade excavations cannot be properly sloped or benched, temporary shoring may be required. CSI should be contacted to evaluate any unstable conditions.

## **8B SITE PREPARATION (WORK PRIOR TO FILLING)**

- The area should be stripped of any topsoil and/or vegetative cover prior to commencing fill operations;
- Areas ready to receive new fill should be proofrolled with a heavily loaded dump truck or similar equipment judged acceptable by the geotechnical engineer;
- The level of proofroll should be determined by the geotechnical engineer on a case-by-case basis;
- Perform the proofrolling after a suitable period of dry weather to avoid degrading the subgrade;
- Areas which pump, rut, or wave during proofrolling may require undercutting, depending on the location of the area and the use of the area, so the geotechnical engineer should be contacted for guidance. It should be anticipated that some stabilization may be necessary at the bearing elevation of the structure. At this time, we anticipate that this would consist of undercutting along with the use of Geogrid and crushed stone.
- Backfill of undercut areas should be done in accordance with section 8C;
- Deleterious materials such as topsoil, roots, wood or other materials that will decay should be removed from the site;
- Retain CSI to observe the proofrolling/subgrade evaluation and make recommendations for any unstable or unsuitable conditions encountered---this can save time on the construction schedule and save unnecessary undercutting;
- We recommend that site grading should take place between about late April to early November. Earthwork taking place outside this time period will likely encounter wet conditions and weather conditions that will provide little to no assistance with drying the soils.

## **8C NEW FILL OPERATIONS (MASS EARTHWORK)**

Before new fill construction, representative samples should be obtained of the proposed fill material to determine the moisture-density relationship, classification of the material, and whether the material is suitable to be used as structural fill. After the subgrade has been approved to receive new fill, the fill may commence with the following procedures and guidelines recommended:

- Place cohesive fill (clay) in maximum 8-inch thick loose lifts. Granular soils may be placed in maximum 12 inch loose lifts provided properly sized equipment is used in the compaction process;
- Fill lifts should be compacted to at least 98 percent of the soil's maximum dry density (ASTM D 698) in areas beneath structures (buildings, equipment foundations and pavements);



- Non-structural areas (i.e. grassed and/or landscape areas) can utilize a lower compaction requirement of 90 percent. Non-structural areas should be considered 5 feet beyond the limits of structural entities (i.e. building, pavements, sidewalks, etc);
- Maintain the moisture content of compacted fill between minus 2 and plus 2 percent of optimum moisture;
- Soils with a plasticity index (PI) of greater than 35 should not be used;
- Maximum particle size of the soil should be limited to half the lift thickness. Equipment should be large enough that any large particles are thoroughly broken up. Large pieces not able to be satisfactorily broken up should be removed from the fill;
- Density testing should be performed as a means to verify percent compaction and moisture content of the material as it is being placed and compacted;
- Observation of fill “stability” is also critical, so it is recommended to observe the operation of the filling equipment traversing over the new fill to document movement (similar to proof rolling);
- Density testing should be performed at a rate of at least one per 10,000 square feet per lift with a minimum of 3 tests per lift;
- Soils should not be “over compacted” and construction traffic should be kept to minimum to assure compaction is achieved and that the soil is not allowed to “break down”;
- Due to the silty nature of on-site soils, repetitive construction traffic, and disturbance will break-down the soils making them unstable; and
- Retain a representative of CSI to observe and document fill placement and compaction operations.

#### **8D GENERAL NOTES**

- For all earthwork operations, positive surface drainage is prudent to keep water from ponding on the surface and to assist in maintaining surface stability;
- The surface should be sealed prior to expected wet weather. This can usually be accomplished with rubber-tired construction equipment or a steel-drum roller;
- If any soil placement problems occur, CSI should be retained to provide additional recommendations, as needed.

### **9 SITE DRAINAGE**

During construction, water should not be allowed to pond in excavations or undercutting will likely be required. During the life of the project, slope the subgrade and other site features so that surface water flows away from the site structures.

For shallow excavations during construction, it is expected that free water from the subsurface conditions could likely be removed via sump pumps and open channel flow (ditches) at or near the source of seepage. It should be expected that groundwater will be encountered in deeper excavations and additional water removal means may be necessary such as dewatering wells, large pumps, or through the use of driven sheet piles to create a seepage barrier around deeper excavations associated with the clear wells and lagoon.



## 10 FOUNDATIONS

Based upon the information provided and the conditions encountered, we anticipate conventional spread footing can be utilized for at grade portions of the structure and a mat foundation to be suitable for the below grade portion.

### 10A SPREAD FOUNDATIONS

Spread footings for the buildings may be sized using a maximum net allowable bearing pressure of 2,000 pounds per square foot (psf). Foundations should penetrate the existing fill and bear within firm or better alluvial soils, or newly compacted fill material placed over suitable materials.

Detailed settlement analysis was beyond the scope of this exploration. However, based on the estimated structure loads, the anticipated behavior of soil types encountered during field activities, and our experience with similar projects, we expect that total settlements will not exceed 1 inch, and that differential settlements will not exceed 3/4 inch between columns or along continuous footing distances of 30 feet or less. We recommend the structures be designed to accommodate this magnitude of total and differential settlement.

Settlement estimates are based, in part, upon the assumption that site preparation is performed in accordance with our recommendations and with good quality control of the earthworks. Removal of unsuitable old fill and proper placement and compaction of new fill is particularly important in keeping settlements within tolerable limits.

Additional design considerations for project foundations are outlined as follows:

- Design all footings with a minimum 18 inches width;
- All exterior footing bottoms should bear at least 24 inches below finished exterior grading;
- Interior footings (those not exposed to freezing) may be placed at nominal depths provided proper they bear on suitable material as recommended in this report;
- Include control joints at suitable intervals in the walls of structures and in areas where changes in support from native soil to fill are anticipated, to help accommodate differential foundation movements.

#### 10A.1 SHALLOW FOUNDATIONS-CONSTRUCTION NOTES

In general, soils tend to lose strength if they become wet. We recommend the foundation subgrades be protected from exposure to water. For foundations construction, we also recommend the following procedures.

- For soils that will remain exposed overnight or for an extended period of time, place a "lean" concrete mudmat (1 to 2 inches) over the bearing areas. This may also be necessary if groundwater is encountered. Flowable fill concrete or low-strength concrete is suitable for this cover, as conditions allow;
- Foundation bearing conditions should be benched level.





- Areas loosened by excavation operations should be recompact prior to reinforcing steel placement.
- Loose soil, debris, and excess surface water should be removed from the bearing surface prior to concrete placement.
- Retain the geotechnical engineer to observe all foundation excavations and provide recommendations for treatment of any unsuitable conditions encountered.
- The bearing conditions of natural soils should be checked by means of portable dynamic cone penetration (DCP) testing at the direction of the geotechnical engineer.
- Even though fill soils placed for foundation support have likely been checked for compaction at the time of placement, these soils may have become wet or lost some level of strength since that time. The areas should be hand probed to check for surface hardness/strength.

## **10B MAT FOUNDATIONS**

Based on our experience with similar structures, we have assumed the below-grade portion of the structure will be supported on a rigid mat foundation with a bearing pressure between 1,500 and 2,000 psf. Given the depth of the excavation, the bearing pressure from the structural loads will essentially be equivalent to the excavated material. Thus relatively little static settlement is anticipated.

At this time, we do not anticipate that bearing capacity will control the design of the structure. Instead, we anticipate that the design will be governed by the soil-structure interaction modeling and the evaluation of the calculated settlement (deflections), shears, and moments. To design the mat foundation, we recommend using a coefficient of vertical subgrade reaction value ranging between 60 and 75 pci for the proposed bearing pressures. The subgrade modulus,  $k$ , is not a fundamental soil property and depends on many other factors including width, shape, and depth below the ground surface of the loaded area, position under the foundation and time (Coduto 2001). With the soils encountered, we anticipated that less than 1 inch of settlement will be experienced. If settlements greater than 1 inch are calculated, then stabilization of the subgrade may be necessary through the use of additional stone or a combination geogrid/stone system. We recommend the slab be designed to be supported on a minimum of 12 inches of granular base material.

## **11 GRADE SUPPORTED FLOOR SLABS**

Grade supported slabs are suitable for the portions of the structure that would be at or near the existing surface elevations, provided the subgrade is prepared according to the recommendations contained within this report. We recommend the slab be supported on a minimum of 6 inches of compacted granular base. The slab should be designed to be structurally independent of any building footings or walls and should be appropriately reinforced to support the proposed loads. For design of the slab, a modulus of subgrade reaction ( $k$ ) of 100 psi/in may be used.

The following features are also recommended as part of the floor slab construction:

- Grade supported slabs should not bear on fill material. The fill should be undercut and replaced with backfill in accordance with Section 8 above.



- Provide isolation joints between the slab and columns and along footing supported walls.
- Adequate joint patterns (ACI and ICC guidelines) should be used to permit slab movement due to normal soil settlement, normal subgrade disturbance and material expansion/contraction.
- Keep the crushed stone or gravel moist, but not wet, immediately prior to slab concrete placement to minimize curling of the slab due to differential curing conditions between the top and bottom of the slab.
- *DO NOT allow soils directly below the slab to become overly wet or dry prior to placement of concrete.*
- Retain CSI to review the actual subgrade conditions prior to slab construction and make recommendations for any unsuitable conditions encountered.

**Note:** Slab subgrade conditions are also considered earthwork areas and the recommendations contained in the Earthwork section of the report should be followed

## 12 SEISMIC DESIGN

The table below provides seismic design parameters for the site in accordance with the 2012/2015 International Building Code (IBC) and the United States Geological Survey (USGS). These parameters have been based upon a Seismic Site Class of a D with a presumed Seismic Risk Category of III or less.

**Table 5: Seismic Design Parameters**

Parameter	Value	2012/2015 IBC Reference
Soil Profile Site Class	D	Section 1613.3.2 Site Class Definitions
0.2 Second Spectral Acceleration, $S_s$	0.151g	Figure 1613.3.1(1)
1.0 Second Spectral Acceleration, $S_1$	0.073g	Figure 1613.3.1(2)
Site Coefficient, $F_a$	1.6	Table 1613.3.3(1)
Site Coefficient, $F_v$	2.4	Table 1613.3.3(2)

## 13 BELOW GRADE WALLS

As mentioned above, the proposed clear wells will be approximately 12 to 15 feet below grade. When backfilling around the clear wells, we recommend that the backfill material be free-draining material such as crushed stone or sand. The recommended backfill should encompass a zone from the base of the foundation to the top of the wall at a 45 degree angle. The backfill zone should be drained using a perforated pipe placed at the base of the footing and connected to a sump or provided some other means of draining. If drainage is not possible, then hydrostatic pressures need to be considered in the design of the walls.



**Table 6: Equivalent Fluid Density (EFD) and Earth Pressure Coefficient**

Condition	Granular Backfill	
	EFD (pcf)	Coefficients
At-Rest	45	$K_o = 0.35$
Active	30	$K_a = 0.22$
Passive	300	$K_p = 2.75$

## 14 LAGOON CONSTRUCTION

Based on our understanding, the proposed lagoon structure will be designed to retain a stable pool of water. Weathered bedrock (shale/sandstone) was encountered in both borings Boring B-9 and B-2 drilled within the proposed lagoon at depths of about 18 to 12 feet below grade, respectively. In addition, a layer of coarse sand and gravel was encountered overlying the weathered rock in boring B-9. Given our experience, groundwater typically flows at the bedrock interface, or within granular soils such as the sand and gravel encountered, and will not provide a condition which will retain water within the lagoon. To retain the water, we recommend that either a clay or HDPE liner be utilized. In using a clay liner, clay soils with a higher plasticity and free of sand and rock fragments are desirable. Our experience has been that a 2 foot thick clay liner will provide satisfactory results, although material properties will ultimately determine the necessary thickness.

## 15 NOTES ON THE REPORT AND RECOMMENDATIONS

We recommend that this complete report be provided to the various design team members, the contractors and the project Owner. Potential contractors should be informed of this report in the "Instructions to Bidders" section of the bid documents. A geotechnical exploration, such as the one we performed, uses widely spaced borings to attempt to model the subsurface conditions at the site. Because no exploration contains complete data or a complete model, there is always a possibility that conditions between borings will be different from those at specific boring locations. Thus, it is possible that some subsurface conditions will not be as anticipated by the project team or contractor. If this report is included or referenced in the actual contract documents, **it shall be explicitly understood that this report is for informational purposes only.** CSI shall not be responsible for the opinions of, or conclusions drawn by others.

It has been our experience that the construction process often disturbs soil conditions and this process, no matter how much experience we use to anticipate construction methodology, is not completely predictable. Therefore, changes or modifications to our recommendations are likely needed due to these possible variances. Experienced CSI geotechnical personnel should be used to observe and document the construction procedures and the conditions encountered. Unanticipated conditions and inadequate procedures should be reported to the design team along with timely recommendations to solve the problems created. We recommend that the Owner retain CSI to provide this service based upon our familiarity with the project, the subsurface conditions and the intent of our recommendations.

This report is based on the supplied project information, the subsurface conditions observed at the time of the report, and our experience with similar conditions. As such, it cannot be applied to other project sites, types, or combinations thereof. If the Project Information section in this report contains incorrect information or if additional information is available, you should convey the correct or additional information to us and retain us to review our recommendations. Our recommendations may then require modification.





No section or portion of this report (including Appendix information) can be used as a stand alone article to make distinct changes or assumptions. The entire report and Appendix should be used together as one resource. We wish to remind you that our exploration services include storing the soil samples collected and making them available for inspection for 30 days. The soil samples are then discarded unless you request otherwise. Please inform us if you wish to keep any of the obtained samples.

While this report deals with samples of subsurface materials and some comments on water conditions at the site, no assessment of site environmental conditions or the presence of contaminants were performed.

We wish to remind you that our exploration services include storing the soil samples collected and making them available for inspection for 30 days. The samples are then discarded unless you request otherwise. Please inform us if you wish to keep any of the obtained samples



## **APPENDIX**

**Site Location Plan  
Boring Location Plan  
Soil Boring Profile  
Test Boring Records  
Field Testing Procedures  
Summary of Soil Laboratory Tests  
Specific Soil Laboratory Test Results  
Soil Laboratory Testing Procedures**



Adapted from Topographic Mapping

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11162 Luscek Drive  
Cincinnati, Ohio 45241  
513.252.2059 Office | 888.792.3121 Fax  
www.csiohio.com

TITLE: SITE LOCATION PLAN

PROJECT: Greenup County  
Water Filtration Plant  
Greenup, Kentucky

Project No:  
CN170040

Date:  
5-3-17

Scale: Not To Scale

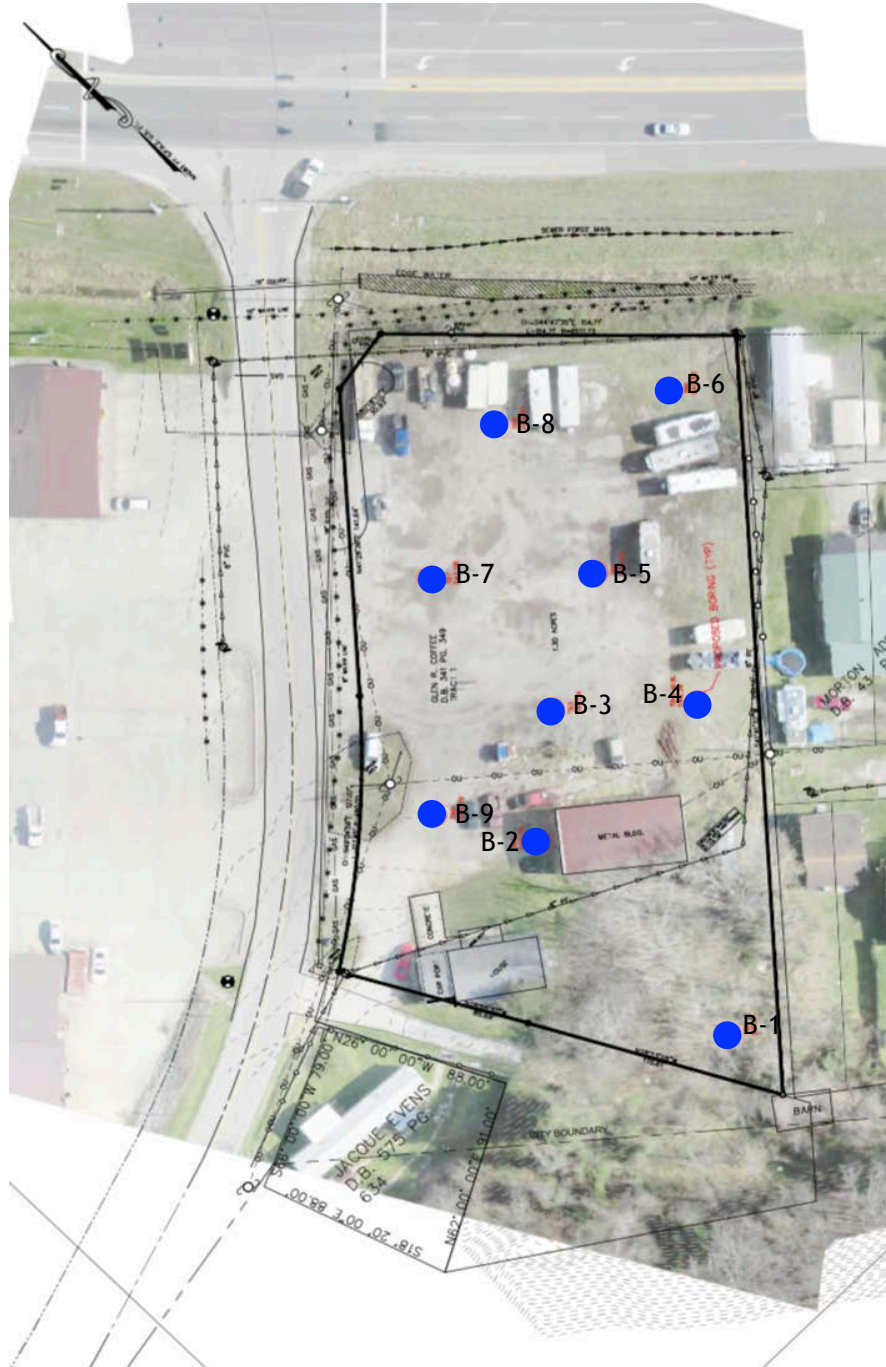
Drawn By:  
GD

Checked By:  
JB

Drawing No:  
1 of 2

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Adapted from Supplied Imagery

LEGEND	
B-XX	BORING LOCATIONS

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TITLE: BORING LOCATION PLAN

PROJECT: Greenup County  
Water Filtration Plant  
Greenup, Kentucky

Project No:  
CN170040

Date:  
5-3-17

Scale: Not To Scale

Drawn By:  
GD

Checked By:  
JB

Drawing No:  
2 of 2

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## Geotechnical Boring Information Sheet

Sample Type Symbols		Definitions
Splitspoon (SPT)		SPT-"Splitspoon" or standard penetration test. Blow counts are number of drops required for a 140 lb hammer dropping 30 inches to drive the sampler 6 inches.
Shelby Tube		N-value is the addition of the last two intervals of the 18-inch sample.
Grab		Shelby tubes are often called "undisturbed samples". They are directly pushed into the ground, twisted, allowed to rest for a small period of time and then pulled out of the ground. Tops and bottoms are cleaned and then sealed.
Rock Core		
Auger Cuttings		
Surface Symbols		Sample classification is done in general accordance with ASTM D2487 and 2488 using the Unified Soil Classification System (USCS) as a general guide.
Topsoil		Soil moisture descriptions are based on the recovered sample observations. The descriptors are dry, slightly moist, moist, very moist and wet. These are typically based on relative estimates of the moisture condition of a visual estimation of the soils optimum moisture content (EOMC). Dry is almost in a "dusty" condition usually 6 or more percent below EOMC. Slightly moist is from about 6 to 2 percent below EOMC at a point at which the soil color does not readily change with the addition of water. Moist is usually 2 percent below to 2 percent above EOMC and the point at which the soil will tend to begin forming "balls" under some pressure in the hand. Very moist is usually from about 2 percent to 6 percent above EOMC and also the point at which it's often considered "muddy". Wet soil is usually 6 or more percent above EOMC and often contains free water or the soil is in a saturated state.
Asphalt		
Concrete		
Lean Clay		
Fat Clay		
Glacial Till		
Sandy Clay		
Silt		
Elastic Silt		
Lean Clay to Fat Clay		
Gravelly Clay		
Sandy Silt		
Gravelly Silt		
Sand		
Gravel		
Fill		Rock hardness is classified as follows: <b>Very Soft:</b> Easily broken by hand pressure <b>Soft:</b> Ends can be broken by hand pressure; easily broken with hammer <b>Medium:</b> Ends easily broken with hammer; middle requires moderate blow <b>Hard:</b> Ends require moderate hammer blow; middle requires several blows <b>Very Hard:</b> Many blows with a hammer required to break core
Limestone		
Sandstone		
Shale/Siltstone		
Weathered Rock		
Samples Strength Descriptors		Rock Quality Designation (RQD) is defined as total combined length of 4" or longer pieces of core divided by the total core run length; defined in percentage.
<b>Cohesive Soils:</b>	<b>N</b>	Water or cave-in observed in borings is at completion of drilling each boring unless otherwise noted.  Strata lengths shown on borings represents a rough estimate. Transition may be more abrupt or gradual. Soil borings are representative of that estimated location at that time and are based on recovered samples. Conditions may be different between borings and between sample intervals. Boring information is not to be considered stand alone but should be taken in context with comments and information in the geotechnical report and the means by which the borings are logged, sampled and drilled.
Very Soft	0-1	
Soft	2-4	
Firm	5-8	
Stiff	9-15	
Very Stiff	16-30	
Hard	31+	
<b>Non-cohesive Soils:</b>		
Very Loose	0-4	
Loose	5-10	
Firm	11-20	
Very Firm	21-30	
Dense	30-50	
Very Dense	51+	

(Shown in Graphic Log)



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Silt

 Clayey Sand Silty Clay Shale

**11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121**

Fig. 1



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 11162 Lushek Drive  
 Cincinnati, Ohio 45241  
 Phone: 513.252.2059  
 Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
 PROJECT NAME Greenup Water Filtration Plant  
 PROJECT LOCATION Greenup, KY

BORING # B-1  
 JOB # CN170040  
 LOGGED BY GD  
 APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 4/4/17 Contractor CSI Drilling  
 Date Completed 4/4/17 Boring Size N/A in.  
 Drill Rig N/A Boring Method Hand  
 Weather Sunny 50's Hammer Type N/A

## TEST DATA

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test N-Value (blows/foot)	Qu-psf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
Elev. (ft)	Depth Scale	Water Level												
SURFACE ELEVATION: 571.7														
			Topsoil (3 in)											
			Brown LEAN CLAY (CL) with trace shale fragments and silt [Colluvium] - moist											
570	2													
568	4													
Boring Terminated at 4 feet; No Refusal														

### Depth to Groundwater

● Noted on Drilling Tools \_\_\_\_\_ ft.  
 ∇ At Completion \_\_\_\_\_ ft.  
 ▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
 ☒ Cave Depth \_\_\_\_\_ ft.

### Sample Type

SPT- Standard Penetration Test  
 SS- Split Spoon  
 ST- Shelby Tube  
 RC- Rock Core  
 CU- Auger Cuttings

### Boring Method

HSA- Hollow Stem Augers  
 CFA- Continuous Flight Augers  
 MD- Mud Drilling



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11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-2  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 4/4/17 Contractor CSI Drilling  
Date Completed 4/4/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penet. Blows per 6" [ N-Value ] blows	Qu-psf Unconfi. Compressive St	Moisture Conte	Liquid Limit (LL)	Plasticity Index	Percent Passing
Elev. (ft)	Depth Scale	Water Level											
SURFACE ELEVATION: 545.8													
544	2		Asphalt (2 in)	1	SS		18	1-2-3 [ 5 ]	2.5				
542	4		Gravel (9 in)	2	SS		18	1-2-2 [ 4 ]	1.75	27.8			
540	6		Fill: Brown and gray LEAN CLAY (CL) with trace rock fragments - moist, firm  Brown and gray mottled LEAN CLAY (CL) with silt and trace rock fragments [Alluvium] - moist, soft to stiff	3	SS		18	3-5-8 [ 13 ]	1.75				
538	8			4	SS		18	2-4-6 [ 10 ]	1.5	26.4			
536	10												
534	12												
532	14	▽	Gray to brown highly weathered and thinly laminated SHALE with varying amounts of sandstone fragments - moist, soft	5	SS		18	6-9-14 [ 23 ]	4.5				
530	16												
528	18			6	SS		5	50/5-- [ 50/5 ]	4.5				
526	20		Auger Refusal at 18.5 feet; Boring Terminated										
524	22												
522	24												
520	26												
518	28												
516	30												
514	32												
512	34												
510	36												
508	38												

### Depth to Groundwater

● Noted on Drilling Tools \_\_\_\_\_ ft.  
▽ At Completion 14.0 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

### Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
ST- Shelby Tube  
RC- Rock Core  
CU- Auger Cuttings

### Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling





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11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-3  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 3/31/17 Contractor CSI Drilling  
Date Completed 3/31/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION													
Elev. (ft)	Depth Scale	Water Level		Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penet. Blows per 6" [ N-Value ] blow	Qu-psf Unconfined Compressive St	Moisture Content	Liquid Limit (LL)	Plasticity Index	Percent Passing
SURFACE ELEVATION: 544.0													
542	2		Asphalt (3 in)	1	SS		2	15-6-4 [ 10 ]	N/A	10.4			
			Gravel (5 in)										
540	4		Fill: Dark brown LEAN CLAY (CL) with rock fragments and silt - moist, stiff	2	SS		15	5-6-6 [ 12 ]	1.25				
538	6		Brown to gray LEAN CLAY (CL) with some silt [Alluvium] - moist, stiff	3	SS		4	2-2-2 [ 4 ]	1	23.3			
536	8	▽	Brown LEAN CLAY (CL) with some silt [Alluvium] - moist, stiff	4	SS		10	2-2-1 [ 3 ]	1.25	28.5	47	19	88
534	10												
532	12												
530	14		Brown SILT (ML) with clay [Alluvium] - moist, soft	5	SS		18	2-3-6 [ 9 ]	4				
528	16												
526	18												
524	20			6	SS		10	1-2-3 [ 5 ]	.5	24.5			
522	22												
520	24		Auger Refusal at 23.4 feet; Boring Terminated										
518	26												
516	28												
514	30												
512	32												
510	34												
508	36												
506	38												

### Depth to Groundwater

● Noted on Drilling Tools \_\_\_\_\_ ft.  
▽ At Completion 8.0 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

### Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
ST- Shelby Tube  
RC- Rock Core  
CU- Auger Cuttings

### Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling



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11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-4  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 4/4/17 Contractor CSI Drilling  
Date Completed 4/4/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penet. Blows per 6" [ N-Value ] blow	Qu-psf Unconfirmitive Compressive St	Moisture Content	Liquid Limit (LL)	Plasticity Index	Percent Passing
Elev. (ft)	Depth Scale	Water Level	SURFACE ELEVATION: 544.3										
544			Topsoil (2 in)										
542	2		FILL: Gray and brown LEAN CLAY (CL) with trace rock fragmetns, sand, and silt - moist, very stiff	1	SS		10	3-4-5 [ 9 ]	4.5				
540	4		Gray LEAN CLAY (CL) with silt and trace roots/wood fibers [Alluvium] - moist, firm	2	SS		18	2-4-3 [ 7 ]	1.75	18.7			
538	6		Gray FAT CLAY (CH) with silt and trace rock fragments [Alluvium] - moist, soft	3	SS		5	1-2-2 [ 4 ]	0.75				
536	8			4	SS		18	1-1-2 [ 3 ]	.5	28.7			
534	10		Brown and gray mottled LEAN CLAY (CL) with some silt [Alluvium] - moist, firm	5	SS		18	4-4-5 [ 9 ]	1.75	17.1			
532	12												
530	14		Brown and gray highly weathered SANDSTONE with trace sand - moist, soft	6	SS		3	50/3-- [ 50/3 ]	N/A				
528	16												
526	18												
524	20												
522	22		Auger Refusal at 21.9 feet; Boring Terminated										
520	24												
518	26												
516	28												
514	30												
512	32												
510	34												
508	36												
	38												

## Depth to Groundwater

● Noted on Drilling Tools 13.5 ft.  
▽ At Completion 15.0 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

## Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
ST- Shelby Tube  
RC- Rock Core  
CU- Auger Cuttings

## Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling



CSI of Cincinnati  
11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-5  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 3/31/17 Contractor CSI Drilling  
Date Completed 3/31/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penet. Blows per 6" [ N-Value ] blow	Qu-psf Unconfirmitive Compressive Strength	Moisture Content	Liquid Limit (LL)	Plasticity Index	Percent Passing	
Elev. (ft)	Depth Scale	Water Level	SURFACE ELEVATION: 543.4											
542	2		Asphalt (3 in)	1	SS		7	5-5-7 [ 12 ]	4	17.1				
			Gravel (9 in)											
540	4		Fill Brown to gray LEAN CLAY (CL) with little silt and trace rock fragments, sand, and asphalt - moist, firm to stiff	2	SS		18	8-5-4 [ 9 ]	N/A					
538	6													
536	8		Gray to brown mottled LEAN CLAY (CL) with silt, trace sand, and rock fragments [Alluvium] - moist, soft	3	SS		10	3-1-2 [ 3 ]	2	24.0				
534	10				4	SS		10	2-3-4 [ 7 ]	2				
532	12		Gray FAT CLAY (CH) with little silt [Alluvium] - moist, firm											
530	14				5	SS		16	4-6-10 [ 16 ]	3	25.3	43	19	87
528	16		Brown and gray LEAN CLAY (CL) with silt [Alluvium] - moist, very stiff											
526	18													
524	20			6	SS		18	2-4-4 [ 8 ]	1.25					
522	22													
520	24	▽		7	SS		10	2-1-2 [ 3 ]	1	28.6				
518	26													
516	28													
514	30			8	SS		15	1-3-6 [ 9 ]	2.25					
512	32		Boring Terminated at 30 feet; No Refusal											
510	34													
508	36													
506	38													

## Depth to Groundwater

● Noted on Drilling Tools \_\_\_\_\_ ft.  
▽ At Completion 24.5 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

## Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
ST- Shelby Tube  
RC- Rock Core  
CU- Auger Cuttings

## Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling



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11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-6  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 3/31/17 Contractor CSI Drilling  
Date Completed 3/31/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [ N-Value ] blows / foot	Qu-psf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
Elev. (ft)	Depth Scale	Water Level	SURFACE ELEVATION: 542.8											
542			Topsoil (3 in)											
540	2		Fill: Dark brown to dark brown and gray LEAN CLAY (CL) with trace rock fragments and silt - moist, stiff	1	SS		10	3-4-3 [ 7 ]	2.5	10.1				
538	4			2	SS		6	4-3-3 [ 6 ]	2	6.7				
536	6		Gray LEAN CLAY (CL) with silt and trace roots [Alluvium] - moist, soft	3	SS		8	2-1-2 [ 3 ]	2					
534	8			4	SS		18	3-3-3 [ 6 ]	2.5	14.2				
532	10		Brown and gray mottled LEAN CLAY (CL) with silt and trace roots [Alluvium] - moist, firm to stiff											
530	12			5	SS		18	3-5-7 [ 12 ]	2.25					
528	14													
526	16			6	SS		18	2-3-4 [ 7 ]	2	29.1				
524	18													
522	20			7	SS		1	3-3-4 [ 7 ]	N/A	27.0				
520	22		Brown fine grained SAND with trace gravel [Alluvium] - wet, firm											
518	24			8	SS		18	3-4-7 [ 11 ]	N/A					
516	26	▽	Boring Terminated at 30 feet; No Refusal											
514	28	●												
512	30													
510	32													
508	34													
506	36													
504	38													

## Depth to Groundwater

● Noted on Drilling Tools 28.5 ft.  
▽ At Completion 26.0 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

## Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
ST- Shelby Tube  
RC- Rock Core  
CU- Auger Cuttings

## Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling



**CSI of Cincinnati**  
11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

# TEST BORING LOG





CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-7  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 4/4/17 Contractor CSI Drilling  
Date Completed 4/4/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penet. Blows per 6" [ N-Value ] blow	Qu-psf Unconfi. Compressive St	Moisture Conte	Liquid Limit (LL)	Plasticity Index	Percent Passing	
Elev. (ft)	Depth Scale	Water Level	SURFACE ELEVATION: 543.1											
542	2		Asphalt (2 in)	1	SS		18	6-4-5 [ 9 ]	4	17.1				
540	4		Gravel (5 in)	2	SS		6	2-2-2 [ 4 ]	1					
538	6		Brown and gray LEAN CLAY (CL) with silt and trace rock fragments - moist, soft to stiff	3	SS		10	1-1-2 [ 3 ]	1.25	29.7				
536	8		Gray LEAN CLAY (CL) with silt and trace wood fibers [Alluvium] - moist, soft	4	SS		18	2-3-3 [ 6 ]	1.75	25.4				
534	10		Brown LEAN CLAY (CL) with little silt [Alluvium] - moist, firm											
532	12		Boring Terminated at 10 feet; No Refusal											
530	14													
528	16													
526	18													
524	20													
522	22													
520	24													
518	26													
516	28													
514	30													
512	32													
510	34													
508	36													
506	38													

### Depth to Groundwater

● Noted on Drilling Tools \_\_\_\_\_ ft.  
▽ At Completion \_\_\_\_\_ ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

### Sample Type

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SS- Split Spoon  
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### Boring Method

HSA- Hollow Stem Augers  
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CSI of Cincinnati  
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Cincinnati, Ohio 45241  
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# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-8  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 4/4/17 Contractor CSI Drilling  
Date Completed 4/4/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

SOIL CLASSIFICATION				TEST DATA										Remarks	
Elev. (ft)	Depth Scale	Water Level		Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [ N-Value ]	blows/foot	Qu-psf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)		Percent Passing #200 Sieve
SURFACE ELEVATION: 542.9															
542	2		Asphalt (5 in)	1	SS		18	5-4-4 [ 8 ]		4.5	20.2				
540	4		Gravel (6 in)	2	SS		18	6-5-3 [ 8 ]		.75					
538	6		Brown and gray LEAN CLAY (CL) with silt and trace rock fragments, roots, and asphalt - moist, soft to stiff	3	SS		18	2-1-2 [ 3 ]		.75	18.7				
536	8				4	SS		16	2-3-4 [ 7 ]		2	26.1	40	19	90
534	10			Brown LEAN CLAY (CL) with silt [Alluvium] - moist firm											
532	12		Brown and gray mottled LEAN CLAY (CL) with silt [Alluvium] - moist, firm	5	SS		18	4-3-4 [ 7 ]		3					
530	14				6	SS		18	2-3-3 [ 6 ]		1.75	29.1			
528	16														
526	18		Gray brown SILT (ML) with clay and little sand [ Alluvium] - moist, stiff	7	SS		18	1-3-6 [ 9 ]		.25	25.6				
524	20				8	SS		18	2-3-3 [ 6 ]		N/A				
522	22														
520	24		Gray to orange brown fine grained SAND with silt [Alluvium] - moist, loose												
518	26														
516	28		Auger Refusal at 32 feet; Boring Terminated												
514	30														
512	32														
510	34														
508	36														
506	38														

## Depth to Groundwater

● Noted on Drilling Tools 23.5 ft.  
▽ At Completion 15.0 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

## Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
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## Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling



CSI of Cincinnati  
11162 Lushek Drive  
Cincinnati, Ohio 45241  
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Fax: 888.792.3121

# TEST BORING LOG

CLIENT Howerton Engineering & Surveying  
PROJECT NAME Greenup Water Filtration Plant  
PROJECT LOCATION Greenup, KY

BORING # B-9  
JOB # CN170040  
LOGGED BY GD  
APPROVED BY JB

## DRILLING and SAMPLING INFORMATION

Date Started 4/4/17 Contractor CSI Drilling  
Date Completed 4/4/17 Boring Size 2.25 in.  
Drill Rig CME-550 Boring Method CFA  
Weather Sunny 50's Hammer Type Manual

## TEST DATA

Date Started <u>4/4/17</u>			Contractor <u>CSI Drilling</u>		
Date Completed <u>4/4/17</u>			Boring Size <u>2.25</u> in.		
Drill Rig <u>CME-550</u>			Boring Method <u>CFA</u>		
Weather <u>Sunny 50's</u>			Hammer Type <u>Manual</u>		

SOIL CLASSIFICATION				Sample No.	Sample Type	Sample Graphics	Recovery (in)	Standard Penetration Test Blows per 6" [ N-Value ] blows/foot	Qu-psf Unconfined (Pocket Pen.) Compressive Strength	Moisture Content %	Liquid Limit (LL)	Plasticity Index (PI)	Percent Passing #200 Sieve	Remarks
Elev. (ft)	Depth Scale	Water Level												
SURFACE ELEVATION: 544.8														
544	2		Fill: Gray brown LEAN CLAY (CL) with some silt and trace roots - moist, firm	1	SS		18	4-4-4 [ 8 ]	2	25.5				
542	4			2	SS		18	1-2-1 [ 3 ]	.5	16.7				
540	6													
538	8	●	Brown LEAN CLAY (CL) with silt [Alluvium] - moist, soft	3	SS		10	1-2-2 [ 4 ]	.75	26.4				
536	10			4	SS		18	1-2-5 [ 7 ]	1.75	27.7	41	19	88	
534	12													
532	14	▽	Brown coarse SAND AND GRAVEL [Alluvium] - moist, very firm	5	SS		10	4-15-15 [ 30 ]	N/A					
530	16													
528	18													
526	20		Auger Refusal at 18.2 feet; Boring Terminated	6	SS		3	50/3-- [ 50/3 ]	N/A					
524	22													
522	24													
520	26													
518	28													
516	30													
514	32													
512	34													
510	36													
508	38													

### Depth to Groundwater

● Noted on Drilling Tools 8.5 ft.  
▽ At Completion 13.3 ft.  
▼ After \_\_\_\_\_ hours \_\_\_\_\_ ft.  
⊠ Cave Depth \_\_\_\_\_ ft.

### Sample Type

SPT- Standard Penetration Test  
SS- Split Spoon  
ST- Shelby Tube  
RC- Rock Core  
CU- Auger Cuttings

### Boring Method

HSA- Hollow Stem Augers  
CFA- Continuous Flight Augers  
MD- Mud Drilling

## FIELD TESTING PROCEDURES

Field Operations: The general field procedures employed by CSI are summarized in ASTM D 420 which is entitled "Investigating and Sampling Soils and Rocks for Engineering Purposes." This recommended practice lists recognized methods for determining soil and rock distribution and ground water conditions. These methods include geophysical and in situ methods as well as borings.

Borings are drilled to obtain subsurface samples using one of several alternate techniques depending upon the subsurface conditions. These techniques are:

- a. Continuous 2-1/2 or 3-1/4 inch I.D. hollow stem augers;
- b. Wash borings using roller cone or drag bits (mud or water);
- c. Continuous flight augers (ASTM D 1425).

These drilling methods are not capable of penetrating through material designated as "refusal materials." Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams, or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

The subsurface conditions encountered during drilling are reported on a field test boring record by the chief driller. The record contains information concerning the boring method, samples attempted and recovered, indications of the presence of various materials such as coarse gravel, cobbles, etc., and observations between samples. Therefore, these boring records contain both factual and interpretive information. The field boring records are on file in our office.

The soil and rock samples plus the field boring records are reviewed by a geotechnical engineer. The engineer classifies the soils in general accordance with the procedures outlined in ASTM D 2488 and prepares the final boring records which are the basis for all evaluations and recommendations.

The final boring records represent our interpretation of the contents of the field records based on the results of the engineering examinations and tests of the field samples. These records depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at these boring locations. Also, the passage of time may result in a change in the subsurface soil and ground water conditions at these boring locations. The lines designating the interface between soil or refusal materials on the records and on profiles represent approximate boundaries. The transition between materials may be gradual. The final boring records are included with this report.

The detailed data collection methods used during this study are discussed on the following pages.

Soil Test Borings: Soil test borings were made at the site at locations shown on the attached Boring Plan. Soil sampling and penetration testing were performed in accordance with ASTM D 1586.

The borings were made by mechanically twisting a hollow stem steel auger into the soil. At regular intervals, the drilling tools were removed and soil samples obtained with a standard 1.4 inch I.D., 2 inch O.D., split tube sampler. The sampler was first seated 6 inches to penetrate any loose cuttings, then driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot was recorded and is designated the "penetration resistance". The penetration resistance, when properly evaluated, is an index to the soil strength and foundation supporting capability.

Representative portions of the soil samples, thus obtained, were placed in glass jars and transported to the laboratory. In the laboratory, the samples were examined to verify the driller's field classifications. Test Boring Records are attached which graphically show the soil descriptions and penetration resistances.

Core Drilling: Refusal materials are materials that cannot be penetrated with the soil drilling methods employed. Refusal, thus indicated, may result from hard cemented soil, soft weathered rock, coarse gravel or boulders, thin rock seams or the upper surface of sound continuous rock. Core drilling procedures are required to determine the character and continuity of refusal materials.

Prior to coring, casing is set in the drilled hole through the overburden soils, if necessary, to keep the hole from caving. Refusal materials are then cored according to ASTM D 2113 using a diamond-studded bit fastened to the



end of a hollow double tube core barrel. This device is rotated at high speeds, and the cuttings are brought to the surface by circulating water. Core samples of the material penetrated are protected and retained in the swivel-mounted inner tube. Upon completion of each drill run, the core barrel is brought to the surface, the core recovered is measured, the samples are removed and the core is placed in boxes for storage.

The core samples are returned to our laboratory where the refusal material is identified and the percent core recovery and rock quality designation is determined by a soils engineer or geologist. The percent core recovery is the ratio of the sample length obtained to the depth drilled, expressed as a percent. The rock quality designation (RQD) is obtained by summing up the length of core recovered, including only the pieces of core which are four inches or longer, and dividing by the total length drilled. The percent core recovery and RQD are related to soundness and continuity of the refusal material. Refusal material descriptions, recoveries, and RQDs are shown on the "Test Boring Records".

Hand Auger Borings and Dynamic Cone Penetration Testing: Hand auger borings are performed manually by CSI field personnel. This consists of manually twisting hand auger tools into the subsurface and extracting "grab" or baggie samples at intervals determined by the project engineer. At the sample intervals, dynamic cone penetration (DCP) testing is performed. This testing involves the manual raising and dropping of a 20 pound hammer, 18 inches. This "driver" head drives a solid-1 $\frac{3}{4}$  inch diameter cone into the ground. DCP "counts" are the number of drops it takes for the hammer to drive three 1 $\frac{3}{4}$  inch increments, recorded as X-Y-Z values.

Test Pits: Test pits are excavated by the equipment available, often a backhoe or trackhoe. The dimensions of the test pits are based on the equipment used and the power capacity of the equipment. Samples are taken from the spoils of typical buckets of the excavator and sealed in jars or "Ziplock" baggies. Dynamic Cone Penetration or hand probe testing is often performed in the upper few feet as OSHA standards allow. Refusal is deemed as the lack of advancement of the equipment with reasonable to full machine effort.

Water Level Readings: Water table readings are normally taken in conjunction with borings and are recorded on the "Test Boring Records". These readings indicate the approximate location of the hydrostatic water table at the time of our field investigation. Where impervious soils are encountered (clayey soils) the amount of water seepage into the boring is small, and it is generally not possible to establish the location of the hydrostatic water table through water level readings. The ground water table may also be dependent upon the amount of precipitation at the site during a particular period of time. Fluctuations in the water table should be expected with variations in precipitation, surface run-off, evaporation and other factors.

The time of boring water level reported on the boring records is determined by field crews as the drilling tools are advanced. The time of boring water level is detected by changes in the drilling rate, soil samples obtained, etc. Additional water table readings are generally obtained at least 24 hours after the borings are completed. The time lag of at least 24 hours is used to permit stabilization of the ground water table which has been disrupted by the drilling operations. The readings are taken by dropping a weighted line down the boring or using an electrical probe to detect the water level surface.

Occasionally the borings will cave-in, preventing water level readings from being obtained or trapping drilling water above the caved-in zone. The cave-in depth is also measured and recorded on the boring records.

### Liquid and Plastic Limits Test Report

The graph plots Plasticity Index (Y-axis, 0 to 60) against Liquid Limit (X-axis, 0 to 100). A diagonal line represents the A-line, and a horizontal line at PI = 7 represents the U-line. The region between the A-line and U-line is divided into CL (Low Plasticity Clay) and ML (Low Plasticity Silty Clay) by a vertical line at LL = 40. The region above the A-line is divided into CH (High Plasticity Clay) and MH (High Plasticity Silty Clay) by a vertical line at LL = 60. Four data points are plotted: a star at (40, 19), a circle at (42, 18.5), a triangle at (45, 19), and a square at (48, 19).

Liquid Limit (LL)	Plasticity Index (PI)	Symbol
40	19	Star
42	18.5	Circle
45	19	Triangle
48	19	Square

[illegible]

11162 Lushek Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

Client: Howerton Engineering & Surveying  
Project Name: Greenup Water Filtration Plant  
Project Number: CN170040  
Project Location: Greenup, KY

## Summary of Laboratory Results

Sheet 1 of 2

Borehole	Depth	Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Classification	Water Content (%)	Unconfined Compressive Strength (tsf)	Dry Density (pcf)	Wet Density (pcf)	Max. Dry Density (pcf)	Opt. Water Content (%)	CBR	Swell (%)	RQD	Percent Recovery	Percent Finer (No. 200)
B-2	3.5	SS					27.8										
B-2	8.5	SS					26.4										
B-3	1.0	SS					10.4										
B-3	6.0	SS					23.3										
B-3	8.5	SS	47	28	19	SILT(ML)	28.5										88
B-3	18.5	SS					24.5										
B-4	3.5	SS					18.7										
B-4	8.5	SS					28.7										
B-4	13.5	SS					17.1										
B-5	1.0	SS					17.1										
B-5	6.0	SS					24.0										
B-5	13.5	SS	43	24	19	LEAN CLAY(CL)	25.3										87
B-5	23.5	SS					28.6										
B-6	1.0	SS					10.1										
B-6	3.5	SS					6.7										
B-6	8.5	SS					14.2										
B-6	18.5	SS					29.1										
B-6	23.5	SS					27.0										
B-7	1.0	SS					17.1										
B-7	6.0	SS					29.7										
B-7	8.5	SS					25.4										
B-8	1.0	SS					20.2										
B-8	6.0	SS					18.7										
B-8	8.5	SS	40	21	19	LEAN CLAY(CL)	26.1										90
B-8	18.5	SS					29.1										
B-8	23.5	SS					25.6										



### CSI of Cincinnati

11162 Luscheck Drive  
Cincinnati, Ohio 45241  
Phone: 513.252.2059  
Fax: 888.792.3121

SS - Split Spoon Sample  
GRAB - Bulk Grab Sample

### PROJECT INFORMATION

Client: Howerton Engineering & Surveying  
Project Name: Greenup Water Filtration Plant  
Project Number: CN170040  
Project Location: Greenup, KY

## Summary of Laboratory Results

Sheet 2 of 2

Borehole	Depth	Sample Type	Liquid Limit	Plastic Limit	Plasticity Index	Classification	Water Content (%)	Unconfined Compressive Strength (tsf)	Dry Density (pcf)	Wet Density (pcf)	Max. Dry Density (pcf)	Opt. Water Content (%)	CBR	Swell (%)	RQD	Percent Recovery	Percent Finer (No. 200)
B-9	1.0	SS					25.5										
B-9	3.5	SS					16.7										
B-9	6.0	SS					26.4										
B-9	8.5	SS	41	22	19	LEAN CLAY(CL)	27.7										88



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11162 Luschek Drive  
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SS - Split Spoon Sample  
GRAB - Bulk Grab Sample

### PROJECT INFORMATION

Client: Howerton Engineering & Surveying  
Project Name: Greenup Water Filtration Plant  
Project Number: CN170040  
Project Location: Greenup, KY

## LABORATORY TESTING PROCEDURES

Soil Classification: Soil classifications provide a general guide to the engineering properties of various soil types and enable the engineer to apply past experience to current problems. In our investigations, samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The soils are classified according to consistency (based on number of blows from standard penetration tests), color and texture. These classification descriptions are included on our "Test Boring Records."

The classification system discussed above is primarily qualitative and for detailed soil classification two laboratory tests are necessary: grain size tests and plasticity tests. Using these test results the soil can be classified according to the AASHTO or Unified Classification Systems (ASTM D 2487). Each of these classification systems and the in-place physical soil properties provides an index for estimating the soil's behavior. The soil classification and physical properties obtained are presented in this report.

Rock Classification: Rock classifications provide a general guide to the engineering properties of various rock types and enable the engineer to apply past experience to current situations. In our explorations, rock core samples obtained during drilling operations are examined in our laboratory and visually classified by an engineer. The rock cores are classified according to relative hardness and RQD (see Guide to Rock Classification Terminology), color, and texture. These classification descriptions are included on our Test Boring Records.

Atterberg Limits: Portions of the samples are taken for Atterberg Limits testing to determine the plasticity characteristics of the soil. The plasticity index (PI) is the range of moisture content over which the soil deforms as a plastic material. It is bracketed by the liquid limit (LL) and the plastic limit (PL). The liquid limit is the moisture content at which the soil becomes sufficiently "wet" to flow as a heavy viscous fluid. The plastic limit is the lowest moisture content at which the soil is sufficiently plastic to be manually rolled into tiny threads. The liquid limit and plastic limit are determined in accordance with ASTM D 4318.

Moisture Content: The Moisture Content is determined according to ASTM D 2216.

Percent Finer Than 200 Sieve: Selected samples of soils are washed through a number 200 sieve to determine the percentage of material less than 0.074 mm in diameter.

Rock Strength Tests: To obtain strength data for rock materials encountered, unconfined compression tests are performed on selected samples. In the unconfined compression test, a cylindrical portion of the rock core is subjected to increasing axial load until it fails. The pressure required to produce failure is recorded, corrected for the length to diameter ratio of the core and reported.

Compaction Tests: Compaction tests are run on representative soil samples to determine the dry density obtained by a uniform compactive effort at varying moisture contents. The results of the test are used to determine the moisture content and unit weight desired in the field for similar soils. Proper field compaction is necessary to decrease future settlements, increase the shear strength of the soil and decrease the permeability of the soil.

The two most commonly used compaction tests are the Standard Proctor test and the Modified Proctor test. They are performed in accordance with ASTM D 698 and D 1557, respectively. Generally, the Standard Proctor compaction test is run on samples from building or parking areas where small compaction equipment is anticipated. The Modified compaction test is generally performed for heavy structures, highways, and other areas where large compaction equipment is expected. In both tests a representative soil sample is placed in a mold and compacted with a compaction hammer. Both tests have three alternate methods.

Test	Method	Hammer Wt./Fall	Mold Diam.	Run on Material Finer Than	No. of Layers	No. of Blows/Layer
Standard D 698	A	5.5 lb./12"	4"	No. 4 sieve	3	25
	B	5.5 lb./12"	4"	3/8" sieve	3	25
	C	5.5 lb./12"	6"	3/4" sieve	3	56

Test	Method	Hammer Wt./Fall	Mold Diam.	Run on Material Finer Than	No. of Layers	No. of Blows/Layer
Modified D 1557	A	10 lb./18"	4"	No. 4 sieve	5	25
	B	10 lb./18"	4"	3/8" sieve	5	25
	C	10 lb./18"	6"	3/4" sieve	5	56

The moisture content and unit weight of each compacted sample is determined. Usually 4 to 5 such tests are run at different moisture contents. Test results are presented in the form of a dry unit weight versus moisture content curve. The compaction method used and any deviations from the recommended procedures are noted in this report.

Laboratory California Bearing Ratio Tests: The California Bearing Ratio, generally abbreviated to CBR, is a punching shear test and is a comparative measure of the shearing resistance of a soil. It provides data that is a semi-empirical index of the strength and deflection characteristics of a soil. The CBR is used with empirical curves to design pavement structures.

A laboratory CBR test is performed according to ASTM D 1883. The results of the compaction tests are utilized in compacting the test sample to the desired density and moisture content for the laboratory California Bearing Ratio test. A representative sample is compacted to a specified density at a specified moisture content. The test is performed on a 6-inch diameter, 4.58-inch-thick disc of compacted soil that is confined in a cylindrical steel mold. The sample is compacted in accordance with Method C of ASTM D 698 or D 1557.

CBR tests may be run on the compacted samples in either soaked or unsoaked conditions. During testing, a piston approximately 2 inches in diameter is forced into the soil sample at the rate of 0.05 inch per minute to a depth of 0.5 inch to determine the resistance to penetration. The CBR is the percentage of the load it takes to penetrate the soil to a 0.1 inch depth compared to the load it takes to penetrate a standard crushed stone to the same depth. Test results are typically shown graphically.