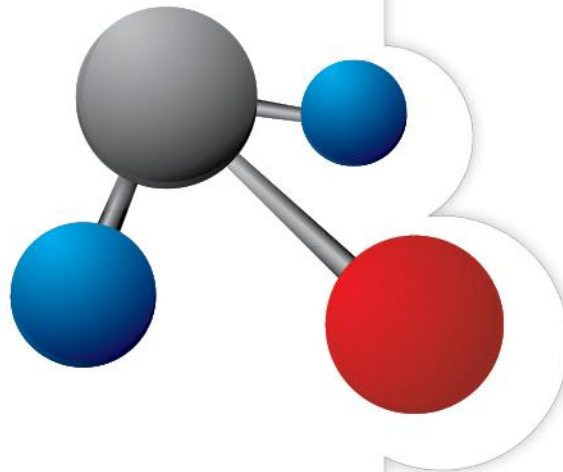


HILL CITY WWTF IMPROVEMENTS

Volume 1 of 2
Div.00 – Div. 23



PREPARED FOR:

Hill City

Hill City,
South Dakota



HILL CITY

HEART OF THE BLACK HILLS™

AE2S Project No. P12021-2023-005

July 2026

PROJECT MANUAL



Advanced Engineering and Environmental Services, LLC.
610 East Boulevard
Rapid City, SD 57701
Ph: 605-341-7800
Web: www.AE2S.com

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DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

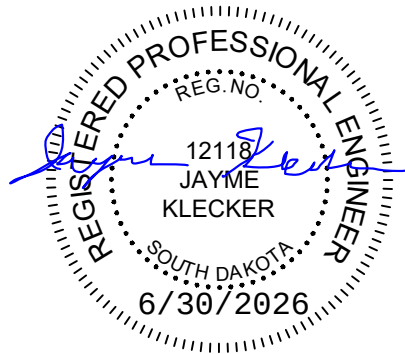
**PLANS AND SPECIFICATIONS
FOR
HILL CITY WWTF IMPROVEMENTS
HILL CITY, SD**

June 2026

CIVIL ENGINEER

I hereby certify that these plans and specifications were prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Responsible for Divisions 00, 01, 02, 31, 32, and 33.



Jayme Klecker, P.E.

Date: 6/30/2026 Reg. No. 12118

STRUCTURAL ENGINEER

I hereby certify that these plans and specifications were prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Responsible for Divisions 03, 05, and 08.



Michael Siewert, P.E.

Date: 6/30/2026 Reg. No. 17478

ELECTRICAL ENGINEER

I hereby certify that these plans and specifications were prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Responsible for Division 26 and Sections 40 53 13, 40 61 33, 40 63 13, 40 63 14, 40 63 43, 40 67 13, 40 70 01, 40 72 00, 40 73 00, 40 74 00, 40 75 00, 40 77 00.



Jacob Wahle, P.E.

Date: 6/30/2026 Reg. No. 17315

MECHANICAL ENGINEER

I hereby certify that these plans and specifications were prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Responsible for Divisions 22 and 23



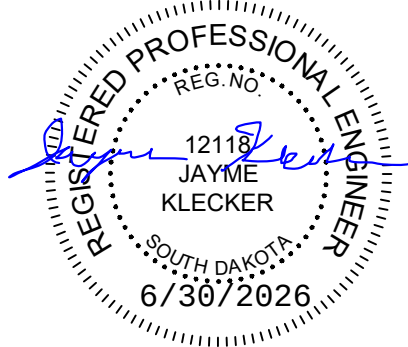
Cody Bartholomew, P.E.

Date: 6/30/2026 Reg. No. 17511

PROCESS ENGINEER

I hereby certify that these plans and specifications were prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of South Dakota.

Responsible for Divisions 40, 43, and 46.



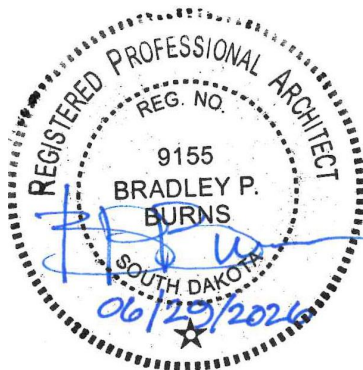
Jayme Klecker, P.E.

Date: 6/30/2026 Reg. No. 12118

ARCHITECT

I hereby certify that these plans and specifications were prepared by me or under my direct supervision and that I am a duly Registered Professional Architect under the laws of the State of South Dakota.

Responsible for Divisions 7 and 10, and Sections 03 35 43, 05 50 00, 05 51 19, 08 11 13, 08 16 13, 08 33 23, and 08 71 00.



Brad Burns, AIA NCARB LEED AP

Date: 6/30/2026 Reg. No. 9155

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WORK AUTHORIZATION: COMPLETE PROJECT WORK PACKAGE

Owner:	City of Hill City, SD	Project No.
Owner's Advisor:	AE2S	P12021-2023-005
Engineer:	AE2S	P12021-2023-005
CMAR:	Scull Construction Services, Inc	P12021-2023-005
Project:	Hill City WWTF Improvements	
Contract Name:	Agreement Between Owner and Construction Manager At Risk	
Work Authorization:	Hill City WWTF Improvements	
Date Issued:	Effective Date of Work Authorization:	

Terms used in this Work Authorization have the meanings stated in the General Conditions and the Supplementary Conditions.

The Contract is modified as follows upon execution of this Work Authorization:

ARTICLE 1—AUTHORIZED WORK

1.01 CMAR shall complete all Work that is specified or indicated in this Work Authorization. The authorized Work is generally described as follows:

A. Hill City WWTF Improvements

1. Site Civil: Includes all work, materials, and equipment related to grading, drainage, site piping, utilities, roadways, paving, and site access.
2. Pretreatment Building (PTB): Includes the construction of a new pretreatment building complete with concrete channels influent channels, screening equipment, vortex grit removal, grit pumping, and flow equalization/distribution to downstream treatment processes. Portions of the building are located below existing grade.
3. Sequencing Batch Reactor (SBR) Treatment System: Construction of a new, below-grade SBR basin containing aeration diffuser, sludge pump, decant mechanism, mechanical mixers, and decant pumping from an adjacent lift station. Some structural elements of SBR2 to be completed under Work Package No. 1.
4. Process Building Equipment Replacement: Demolition and replacement of equipment located in the existing process building including UV disinfection equipment and aeration piping. Also includes installation of a new process blower, fuzzy filter, effluent reuse pump, and all associated piping and valving.
5. Electrical Distribution Building (EB): Installation of a new electrical building and electrical gear including process controls, switch gear, back-up power, and all necessary conduit to supply power throughout the site.

- 1.02 The authorized Work Package is more fully defined in Exhibit A.

ARTICLE 2—COMPENSATION

- 2.01 Owner shall pay CMAR for the completion of the Work Package described in this Work Authorization in accordance with the provisions set forth in the Agreement.
- 2.02 Lump Sum Work
- A. Compensation for all Work is a lump sum amount of \$[number].

ARTICLE 3—CONTRACT TIMES

- 3.01 CMAR agrees to perform the Work set forth in this Work Authorization pursuant to the following schedule:
- A. The Work will be substantially completed on or before December 16, 2027 and completed and ready for final payment in accordance with Paragraph 15.06 of the General Conditions on or before January 15, 2028.
- 3.02 Liquidated damages have been established for the Work covered in this Work Authorization. CMAR will complete the Work covered in this Work Authorization in a timely manner that will (a) allow CMAR to meet the Substantial Completion and final completion requirements of the Contract, and (b) avoid any adverse impact on the completion of other Work Authorizations for which a Milestone has been established.

ARTICLE 4—CONTRACT DOCUMENTS

- 4.01 Contract Documents for Work Authorization
- A. The Contract Documents are identified in the Agreement, Article 16. The following provisions do not limit or modify the Contract Documents.
- B. The Contract Documents with specific applicability to this Work Authorization consist of the following:
1. This Work Authorization, including any exhibits identified as Contract Documents.
 2. Bonds
 - a. Performance bond, together with power of attorney.
 - b. Payment bond, together with power of attorney.
 3. The following which may be delivered or issued on or after the Effective Date of the Work Authorization and are not attached hereto:
 - a. Contract Amendments pertaining to this Work Authorization
 - b. Change Orders, Work Change Directives, and Field Orders that modify this Work Authorization.
 4. Drawings and Specifications shown in Exhibit A as included parts of the Work Package (or Work Packages) authorized in this Work Authorization.

- C. The Contract Documents may only be amended, modified, or supplemented as provided in the Contract.

ARTICLE 5—EXECUTION

	Issued by Owner's Advisor	Authorized by Owner
By:	_____	_____
Title:	_____	_____
Date:	_____	_____
	Accepted by CMAR	Approved by Funding Agency (if applicable)
By:	_____	_____
Title:	_____	_____
Date:	_____	_____

EXHIBIT A—DESIGN DOCUMENTS

ARTICLE 1—SPECIFICATIONS

- 1.01 Specifications entitled Hill City WWTF Improvements.
- 1.02 Specifications listed in the table of contents.
- 1.03 Drawings, not attached but incorporated by reference, consisting of sheets bearing the following general title: Hill City WWTF Improvements.
- 1.04 Drawings listed on the sheet index in the Drawings.

ARTICLE 2—APPENDICES

- 2.01 The following appendices to this Work Authorization are hereby identified as Contract Documents:
 - A. None
- 2.02 Other appendices to this Work Authorization, enumerated as follows; are not Contract Documents:
 - A. None

EXHIBIT B –WORK AUTHORIZATION COMPENSATION

Application for Payment	Summary																																
Owner: _____ CMAR: _____ Owner's Advisor: _____ Engineer: _____ Project: _____ Contract: _____ Project Number _____																																	
Application No.: _____ Application Date: _____ Application Period from: _____ to _____																																	
CMAR Services	<table border="1" style="width: 100%; border-collapse: collapse;"><thead><tr><th style="width: 10%;"></th><th style="width: 40%; text-align: center;">Contract Amount</th><th style="width: 10%;"></th><th style="width: 40%; text-align: center;">Amount Earned</th></tr></thead><tbody><tr><td style="text-align: right;">1</td><td style="text-align: center;">\$ -</td><td style="text-align: right;">2</td><td style="text-align: center;">\$ -</td></tr></tbody></table>		Contract Amount		Amount Earned	1	\$ -	2	\$ -																								
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	<table border="1" style="width: 100%; border-collapse: collapse;"><thead><tr><th style="width: 10%;"></th><th style="width: 40%; text-align: center;">Contract Amount</th><th style="width: 10%;"></th><th style="width: 40%; text-align: center;">Amount Earned</th></tr></thead><tbody><tr><td style="text-align: right;">3</td><td style="text-align: center;">\$ -</td><td style="text-align: right;">4</td><td style="text-align: center;">\$ -</td></tr><tr><td style="text-align: right;">5</td><td style="text-align: center;">\$ -</td><td style="text-align: right;">6</td><td style="text-align: center;">\$ -</td></tr><tr><td style="text-align: right;">7</td><td style="text-align: center;">\$ -</td><td style="text-align: right;">8</td><td style="text-align: center;">\$ -</td></tr><tr><td style="text-align: right;">9</td><td style="text-align: center;">\$ -</td><td></td><td></td></tr><tr><td style="text-align: right;">10</td><td style="text-align: center;">\$ -</td><td></td><td></td></tr><tr><td style="text-align: right;">11</td><td style="text-align: center;">\$ -</td><td></td><td></td></tr><tr><td style="text-align: right;">12</td><td style="text-align: center;">\$ -</td><td></td><td></td></tr></tbody></table>		Contract Amount		Amount Earned	3	\$ -	4	\$ -	5	\$ -	6	\$ -	7	\$ -	8	\$ -	9	\$ -			10	\$ -			11	\$ -			12	\$ -		
	Contract Amount		Amount Earned																														
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11	\$ -																																
12	\$ -																																
Summary of Net Earned Amounts and Payment Due for CMAR Services and Construction																																	
Total Amount Earned for CMAR Services and Total Construction Costs	13 \$ -																																
Total Net Retainage	14 \$ -																																
Amount Earned this Application for Payment	15 \$ -																																
Amount Earned from prior Application for Payment	16																																
Net Amount Earned this Application for payment	17 \$ -																																
Set-offs applied this Application for Payment	18 \$ -																																
Payment Due	19 \$ -																																
The undersigned Construction Manager at Risk certifies that all CMAR Services and Work, including materials, covered by this Application for Payment have been completed or delivered in accordance with the Contract Documents, that all amounts have been duly paid to Subcontractor and Suppliers for CMAR Services, Work, materials, and equipment for which previous Payment has been made by the Owner, and that the current payment amount shown in this Application for Payment is now due. Construction Manager at Risk: _____ Signature: _____ Date: _____																																	
Recommended by Owner's Advisor	Approved by Funding Agency																																
By: _____	By: _____																																
Title: _____	Title: _____																																
Date: _____	Date: _____																																
Approved by Owner	Approved by Owner																																
By: _____	By: _____																																
Title: _____	Title: _____																																
Date: _____	Date: _____																																

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PERFORMANCE BOND

Contractor Name: Address <i>(principal place of business)</i> :	Surety Name: Address <i>(principal place of business)</i> :
Owner Name: Mailing address <i>(principal place of business)</i> :	Contract Description <i>(name and location)</i> : Hill City WWTF Improvements; Hill City, SD Contract Price: Effective Date of Contract:
Bond Bond Amount: Date of Bond: <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i> Modifications to this Bond form: ☐ None ☐ See Paragraph 16	
Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Performance Bond, do each cause this Performance Bond to be duly executed by an authorized officer, agent, or representative.	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i> 	<i>(Full formal name of Surety) (corporate seal)</i>
By: <i>(Signature)</i>	By: <i>(Signature)(Attach Power of Attorney)</i>
Name: <i>(Printed or typed)</i>	Name: <i>(Printed or typed)</i>
Title:	Title:
Attest: <i>(Signature)</i>	Attest: <i>(Signature)</i>
Name: <i>(Printed or typed)</i>	Name: <i>(Printed or typed)</i>
Title:	Title:
<i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner for the performance of the Construction Contract, which is incorporated herein by reference.
2. If the Contractor performs the Construction Contract, the Surety and the Contractor shall have no obligation under this Bond, except when applicable to participate in a conference as provided in Paragraph 3.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation under this Bond will arise after:
 - 3.1. The Owner first provides notice to the Contractor and the Surety that the Owner is considering declaring a Contractor Default. Such notice may indicate whether the Owner is requesting a conference among the Owner, Contractor, and Surety to discuss the Contractor's performance. If the Owner does not request a conference, the Surety may, within five (5) business days after receipt of the Owner's notice, request such a conference. If the Surety timely requests a conference, the Owner shall attend. Unless the Owner agrees otherwise, any conference requested under this Paragraph 3.1 will be held within ten (10) business days of the Surety's receipt of the Owner's notice. If the Owner, the Contractor, and the Surety agree, the Contractor shall be allowed a reasonable time to perform the Construction Contract, but such an agreement does not waive the Owner's right, if any, subsequently to declare a Contractor Default;
 - 3.2. The Owner declares a Contractor Default, terminates the Construction Contract and notifies the Surety; and
 - 3.3. The Owner has agreed to pay the Balance of the Contract Price in accordance with the terms of the Construction Contract to the Surety or to a contractor selected to perform the Construction Contract.
4. Failure on the part of the Owner to comply with the notice requirement in Paragraph 3.1 does not constitute a failure to comply with a condition precedent to the Surety's obligations, or release the Surety from its obligations, except to the extent the Surety demonstrates actual prejudice.
5. When the Owner has satisfied the conditions of Paragraph 3, the Surety shall promptly and at the Surety's expense take one of the following actions:
 - 5.1. Arrange for the Contractor, with the consent of the Owner, to perform and complete the Construction Contract;
 - 5.2. Undertake to perform and complete the Construction Contract itself, through its agents or independent contractors;
 - 5.3. Obtain bids or negotiated proposals from qualified contractors acceptable to the Owner for a contract for performance and completion of the Construction Contract, arrange for a contract to be prepared for execution by the Owner and a contractor selected with the Owners concurrence, to be secured with performance and payment bonds executed by a qualified surety equivalent to the bonds issued on the Construction Contract, and pay to the Owner the amount of damages as described in Paragraph 7 in excess of the Balance of the Contract Price incurred by the Owner as a result of the Contractor Default; or
 - 5.4. Waive its right to perform and complete, arrange for completion, or obtain a new contractor, and with reasonable promptness under the circumstances:

- 5.4.1 After investigation, determine the amount for which it may be liable to the Owner and, as soon as practicable after the amount is determined, make payment to the Owner; or
 - 5.4.2 Deny liability in whole or in part and notify the Owner, citing the reasons for denial.
- 6. If the Surety does not proceed as provided in Paragraph 5 with reasonable promptness, the Surety shall be deemed to be in default on this Bond seven days after receipt of an additional written notice from the Owner to the Surety demanding that the Surety perform its obligations under this Bond, and the Owner shall be entitled to enforce any remedy available to the Owner. If the Surety proceeds as provided in Paragraph 5.4, and the Owner refuses the payment, or the Surety has denied liability, in whole or in part, without further notice, the Owner shall be entitled to enforce any remedy available to the Owner.
- 7. If the Surety elects to act under Paragraph 5.1, 5.2, or 5.3, then the responsibilities of the Surety to the Owner will not be greater than those of the Contractor under the Construction Contract, and the responsibilities of the Owner to the Surety will not be greater than those of the Owner under the Construction Contract. Subject to the commitment by the Owner to pay the Balance of the Contract Price, the Surety is obligated, without duplication for:
 - 7.1. the responsibilities of the Contractor for correction of defective work and completion of the Construction Contract;
 - 7.2. additional legal, design professional, and delay costs resulting from the Contractor's Default, and resulting from the actions or failure to act of the Surety under Paragraph 5; and
 - 7.3. liquidated damages, or if no liquidated damages are specified in the Construction Contract, actual damages caused by delayed performance or non-performance of the Contractor.
- 8. If the Surety elects to act under Paragraph 5.1, 5.3, or 5.4, the Surety's liability is limited to the amount of this Bond.
- 9. The Surety shall not be liable to the Owner or others for obligations of the Contractor that are unrelated to the Construction Contract, and the Balance of the Contract Price will not be reduced or set off on account of any such unrelated obligations. No right of action will accrue on this Bond to any person or entity other than the Owner or its heirs, executors, administrators, successors, and assigns.
- 10. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
- 11. Any proceeding, legal or equitable, under this Bond must be instituted in any court of competent jurisdiction in the location in which the work or part of the work is located and must be instituted within two years after a declaration of Contractor Default or within two years after the Contractor ceased working or within two years after the 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 periods of limitations available to sureties as a defense in the jurisdiction of the suit will be applicable.
- 12. Notice to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears.
- 13. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted therefrom and provisions conforming to such

statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.

14. Definitions

- 14.1. *Balance of the Contract Price*—The total amount payable by the Owner to the Contractor under the Construction Contract after all proper adjustments have been made including allowance for the Contractor for any amounts received or to be received by the Owner in settlement of insurance or other claims for damages to which the Contractor is entitled, reduced by all valid and proper payments made to or on behalf of the Contractor under the Construction Contract.
 - 14.2. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and changes made to the agreement and the Contract Documents.
 - 14.3. *Contractor Default*—Failure of the Contractor, which has not been remedied or waived, to perform or otherwise to comply with a material term of the Construction Contract.
 - 14.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
 - 14.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
15. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
16. Modifications to this Bond are as follows: **None**

PAYMENT BOND

Contractor Name: Address <i>(principal place of business)</i> :	Surety Name: Address <i>(principal place of business)</i> :
Owner Name: Mailing address <i>(principal place of business)</i> :	Contract Description <i>(name and location)</i> : Hill City WWTF Improvements; Hill City, SD Contract Price: Effective Date of Contract:
Bond Bond Amount: [Amount] Date of Bond: [Date] <i>(Date of Bond cannot be earlier than Effective Date of Contract)</i> Modifications to this Bond form: ☐ None ☐ See Paragraph 18	
Surety and Contractor, intending to be legally bound hereby, subject to the terms set forth in this Payment Bond, do each cause this Payment Bond to be duly executed by an authorized officer, agent, or representative.	
Contractor as Principal	Surety
<i>(Full formal name of Contractor)</i>	<i>(Full formal name of Surety) (corporate seal)</i>
By: _____ <i>(Signature)</i>	By: _____ <i>(Signature)(Attach Power of Attorney)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
Attest: _____ <i>(Signature)</i>	Attest: _____ <i>(Signature)</i>
Name: _____ <i>(Printed or typed)</i>	Name: _____ <i>(Printed or typed)</i>
Title: _____	Title: _____
<i>Notes: (1) Provide supplemental execution by any additional parties, such as joint venturers. (2) Any singular reference to Contractor, Surety, Owner, or other party is considered plural where applicable.</i>	

1. The Contractor and Surety, jointly and severally, bind themselves, their heirs, executors, administrators, successors, and assigns to the Owner to pay for labor, materials, and equipment furnished for use in the performance of the Construction Contract, which is incorporated herein by reference, subject to the following terms.
2. If the Contractor promptly makes payment of all sums due to Claimants, and defends, indemnifies, and holds harmless the Owner from claims, demands, liens, or suits by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, then the Surety and the Contractor shall have no obligation under this Bond.
3. If there is no Owner Default under the Construction Contract, the Surety's obligation to the Owner under this Bond will arise after the Owner has promptly notified the Contractor and the Surety (at the address described in Paragraph 13) of claims, demands, liens, or suits against the Owner or the Owner's property by any person or entity seeking payment for labor, materials, or equipment furnished for use in the performance of the Construction Contract, and tendered defense of such claims, demands, liens, or suits to the Contractor and the Surety.
4. When the Owner has satisfied the conditions in Paragraph 3, the Surety shall promptly and at the Surety's expense defend, indemnify, and hold harmless the Owner against a duly tendered claim, demand, lien, or suit.
5. The Surety's obligations to a Claimant under this Bond will arise after the following:
 - 5.1. Claimants who do not have a direct contract with the Contractor
 - 5.1.1. have furnished a written notice of non-payment to the Contractor, stating with substantial accuracy the amount claimed and the name of the party to whom the materials were, or equipment was, furnished or supplied or for whom the labor was done or performed, within ninety (90) days after having last performed labor or last furnished materials or equipment included in the Claim; and
 - 5.1.2. have sent a Claim to the Surety (at the address described in Paragraph 13).
 - 5.2. Claimants who are employed by or have a direct contract with the Contractor have sent a Claim to the Surety (at the address described in Paragraph 13).
6. If a notice of non-payment required by Paragraph 5.1.1 is given by the Owner to the Contractor, that is sufficient to satisfy a Claimant's obligation to furnish a written notice of non-payment under Paragraph 5.1.1.
7. When a Claimant has satisfied the conditions of Paragraph 5.1 or 5.2, whichever is applicable, the Surety shall promptly and at the Surety's expense take the following actions:
 - 7.1. Send an answer to the Claimant, with a copy to the Owner, within sixty (60) days after receipt of the Claim, stating the amounts that are undisputed and the basis for challenging any amounts that are disputed; and
 - 7.2. Pay or arrange for payment of any undisputed amounts.
 - 7.3. The Surety's failure to discharge its obligations under Paragraph 7.1 or 7.2 will not be deemed to constitute a waiver of defenses the Surety or Contractor may have or acquire as to a Claim, except as to undisputed amounts for which the Surety and Claimant have reached agreement. If, however, the Surety fails to discharge its obligations under Paragraph 7.1 or 7.2, the Surety shall indemnify the Claimant for the reasonable attorney's fees the Claimant incurs thereafter to recover any sums found to be due and owing to the Claimant.

8. The Surety's total obligation will not exceed the amount of this Bond, plus the amount of reasonable attorney's fees provided under Paragraph 7.3, and the amount of this Bond will be credited for any payments made in good faith by the Surety.
9. Amounts owed by the Owner to the Contractor under the Construction Contract will be used for the performance of the Construction Contract and to satisfy claims, if any, under any construction performance bond. By the Contractor furnishing and the Owner accepting this Bond, they agree that all funds earned by the Contractor in the performance of the Construction Contract are dedicated to satisfying obligations of the Contractor and Surety under this Bond, subject to the Owner's priority to use the funds for the completion of the work.
10. The Surety shall not be liable to the Owner, Claimants, or others for obligations of the Contractor that are unrelated to the Construction Contract. The Owner shall not be liable for the payment of any costs or expenses of any Claimant under this Bond, and shall have under this Bond no obligation to make payments to or give notice on behalf of Claimants, or otherwise have any obligations to Claimants under this Bond.
11. The Surety hereby waives notice of any change, including changes of time, to the Construction Contract or to related subcontracts, purchase orders, and other obligations.
12. No suit or action will be commenced by a Claimant under this Bond other than in a court of competent jurisdiction in the state in which the project that is the subject of the Construction Contract is located or after the expiration of one year from the date (1) on which the Claimant sent a Claim to the Surety pursuant to Paragraph 5.1.2 or 5.2, 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 will be applicable.
13. Notice and Claims to the Surety, the Owner, or the Contractor must be mailed or delivered to the address shown on the page on which their signature appears. Actual receipt of notice or Claims, however accomplished, will be sufficient compliance as of the date received.
14. When this Bond has been furnished to comply with a statutory or other legal requirement in the location where the construction was to be performed, any provision in this Bond conflicting with said statutory or legal requirement will be deemed deleted here from and provisions conforming to such statutory or other legal requirement will be deemed incorporated herein. When so furnished, the intent is that this Bond will be construed as a statutory bond and not as a common law bond.
15. Upon requests by any person or entity appearing to be a potential beneficiary of this Bond, the Contractor and Owner shall promptly furnish a copy of this Bond or shall permit a copy to be made.
16. Definitions
 - 16.1. *Claim*—A written statement by the Claimant including at a minimum:
 - 16.1.1. The name of the Claimant;
 - 16.1.2. The name of the person for whom the labor was done, or materials or equipment furnished;
 - 16.1.3. A copy of the agreement or purchase order pursuant to which labor, materials, or equipment was furnished for use in the performance of the Construction Contract;
 - 16.1.4. A brief description of the labor, materials, or equipment furnished;

- 16.1.5. The date on which the Claimant last performed labor or last furnished materials or equipment for use in the performance of the Construction Contract;
 - 16.1.6. The total amount earned by the Claimant for labor, materials, or equipment furnished as of the date of the Claim;
 - 16.1.7. The total amount of previous payments received by the Claimant; and
 - 16.1.8. The total amount due and unpaid to the Claimant for labor, materials, or equipment furnished as of the date of the Claim.
- 16.2. *Claimant*—An individual or entity having a direct contract with the Contractor or with a subcontractor of the Contractor to furnish labor, materials, or equipment for use in the performance of the Construction Contract. The term Claimant also includes any individual or entity that has rightfully asserted a claim under an applicable mechanic's lien or similar statute against the real property upon which the Project is located. The intent of this Bond is to include without limitation in the terms of "labor, materials, or equipment" that part of the water, gas, power, light, heat, oil, gasoline, telephone service, or rental equipment used in the Construction Contract, architectural and engineering services required for performance of the work of the Contractor and the 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.
- 16.3. *Construction Contract*—The agreement between the Owner and Contractor identified on the cover page, including all Contract Documents and all changes made to the agreement and the Contract Documents.
- 16.4. *Owner Default*—Failure of the Owner, which has not been remedied or waived, to pay the Contractor as required under the Construction Contract or to perform and complete or comply with the other material terms of the Construction Contract.
- 16.5. *Contract Documents*—All the documents that comprise the agreement between the Owner and Contractor.
17. If this Bond is issued for an agreement between a contractor and subcontractor, the term Contractor in this Bond will be deemed to be Subcontractor and the term Owner will be deemed to be Contractor.
18. Modifications to this Bond are as follows: **[Describe modification or enter "None"]**

CERTIFICATE OF SUBSTANTIAL COMPLETION OF THE WORK

		Project No.
Owner:	_____	_____
Owner's Advisor:	_____	_____
Engineer:	_____	_____
Construction Manager at Risk:	_____	_____
Project:	_____	
Contract Name:	_____	
Contract Amendment:	_____	
Date Issued:	_____	Date of Substantial Completion: _____

This ☐ Preliminary ☐ Final Certificate of Substantial Completion of the Work applies to:

☐ All Work ☐ The following specified portions of the Work:

Date of Substantial Completion of the Work: **12/16/2027**

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Construction Manager at Risk, Owner's Advisor, and Engineer, and found by Owner's Advisor, in consultation with Engineer, to be substantially complete. The Date of Substantial Completion of the Work, the Work authorized under the specific Work Authorization, or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion of the Work. Subject to the provisions of the Contract, the date of Substantial Completion of the Work in the final Certificate of Substantial Completion of the Work marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Construction Manager at Risk to complete all Work in accordance with the Contract Documents.

Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Construction Manager at Risk; see Paragraph 15.04.D of the General Conditions.

The responsibilities between Owner and Construction Manager at Risk for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work must be as provided in the Contract, except as amended as follows:

Amendments to Owner's Responsibilities: ☐ None ☐ As follows:

[List amendments to Owner's Responsibilities]

Amendments to Construction Manager at Risk's Responsibilities: ☐ None ☐ As follows:

[List amendments to Construction Manager at Risk's Responsibilities]

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

[List attachments such as punch list; other documents]

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

Approved by Engineer

Issued by Owner's Advisor

By (signature): _____

Name (printed): _____

Title: _____

NOTICE OF THE ACCEPTABILITY OF THE WORK

		Project No.
Owner:	City of Hill City, SD	P12021-2023-005
Owner's Advisor:	AE2S	P12021-2023-005
Engineer:	AE2S	P12021-2023-005
Construction Manager at Risk:	Scul Construction Services, Inc	P12021-2023-005
Project:	Hill City WWTF Improvements	
Contract Name (Contract):	Agreement Between Owner and Construction Manager At Risk	
Notice Date:	Effective Date of the Contract:	

In support of its recommendation of payment of the Construction Manager at Risk's final Application for Payment, the Owner's Advisor hereby gives notice to the Owner and Construction Manager at Risk, with Engineer's express approval, that the Work furnished and performed by Construction Manager at Risk under the Contract is acceptable, expressly subject to the provisions of the Contract Documents, and of the Agreement between Owner and Owner's Advisor dated **[date of such agreement]** (Owner-Owner's Advisor Agreement) and the Agreement between Owner and Engineer for Professional Services dated **[date of such professional services agreement]** (Owner-Engineer Agreement). This Notice of the Acceptability of the Work (Notice) is made expressly subject to the following terms and conditions to which all who receive and rely on said Notice agree:

1. Owner's Advisor has prepared and issued this Notice with the skill and care ordinarily used by members of Owner's Advisor's profession practicing under similar conditions at the same time and in the same locality.
2. Engineer's express approval of this Notice has been granted with the skill and care ordinarily used by members of the engineering profession practicing under similar conditions at the same time and in the same locality.
3. This Notice reflects and is an expression of the professional opinions of Owner's Advisor and Engineer.
4. This Notice has been prepared to the best of Owner's Advisor's and Engineer's knowledge, information, and belief as of the Notice Date.
5. This Notice is based entirely on and expressly limited by the scope of services that Owner's Advisor and Engineer have been employed by Owner to perform or furnish during construction of the Work, including observation of the Construction Manager at Risk's Work, under the Owner-Owner's Advisor Agreement and the Owner-Engineer Agreement, and applies only to facts that are within Owner's Advisor's or Engineer's respective knowledge, or could reasonably have been ascertained by Owner's Advisor or Engineer, respectively, as a result of carrying out the responsibilities specifically assigned to Owner's Advisor or Engineer under such Owner-Owner's Advisor Agreement or Owner-Engineer Agreement.
6. This Notice is not a guarantee or warranty of Construction Manager at Risk's performance under the Contract, an acceptance of Work that is not in accordance with the Contract Documents, including but not limited to defective Work discovered after final inspection, nor an assumption of responsibility for any failure of Construction Manager at Risk to furnish and perform the Work thereunder in accordance with the Contract Documents, or to otherwise comply with the Contract Documents or the terms of any special guarantees specified therein.

7. This Notice does not relieve Construction Manager at Risk of any surviving obligations under the Contract and is subject to Owner's reservations of rights with respect to completion and final payment.

	Approved by Engineer	Issued by Owner's Advisor
By (signature):	_____	_____
Name (printed):	_____	_____
Title:	_____	_____

STATE REVOLVING FUND (SRF)

GENERAL CONDITIONS

with

DAVIS-BACON & American Iron and Steel Provisions

South Dakota
Department of Agriculture
and Natural Resources

These provisions must be included in the specifications for all Clean Water SRF
and Drinking Water SRF projects.

June 2025

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GUIDANCE FOR UTILIZATION OF DISADVANTAGED BUSINESS ENTERPRISES REQUIREMENTS OF 40 CFR §33.

A. REQUIREMENTS

1. The recipient and prime contractor will exercise good faith efforts to attract and utilize small, minority, and women's business enterprises primarily through outreach, recruitment, and race/gender neutral activities; at a minimum, fulfillment of the six affirmative steps set forth below:
 - a. Including disadvantaged businesses on solicitation lists;
 - b. Assuring that disadvantaged businesses are solicited whenever they are potential sources;
 - c. Dividing total requirements, when economically feasible, into small tasks or quantities to permit maximum participation by disadvantaged businesses;
 - d. Establishing delivery schedules, when the requirements of the work permit, which will encourage participation by disadvantaged businesses;
 - e. Using the services of the Small Business Administration and the Office of Minority Business Enterprise of the U.S. Department of Commerce, as appropriate; and
 - f. Require a. through e. to be taken if subcontracts are awarded.

B. FAIR SHARE OBJECTIVE

1. The fair share objective for this project is 1.5 % MBE's and 2.4 % WBE's.

C. DEFINITIONS

1. Disadvantaged Business Enterprise (DBE) is a business concern which meets the qualifications of a Minority Business Enterprise (MBE), Women's Business Enterprise (WBE), Small Business (SBE), or Small Business in a Rural Area (SBRA).
2. Minority Business Enterprise (MBE) is a business concern which is:
 - a. Certified as socially and economically disadvantaged by the Small Business Administration;
 - (1) Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities.
 - (2) Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system is impaired due to diminished capital and credit opportunities, as compared to others in the same business area who are not socially disadvantaged. In determining the degree of diminished credit and capital opportunities, the Small Business Administration shall consider, but not be limited to, the assets and net worth of such socially disadvantaged individuals. Individuals who certify that they are members of named groups (Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Asian-Indian Americans), are to be considered socially and economically disadvantaged. Economically and socially disadvantaged individuals are deemed to include women.
 - b. Certified as a minority business enterprise by a State or Federal agency; and

- c. An independent business concern which is at least 51 percent owned and controlled by minority group member(s).

(1) A minority group member is an individual who is a citizen of the United States and one of the following:

- (a) Black American;
- (b) Hispanic American (with origins from Puerto Rico, Mexico, Cuba, South or Central America)
- (c) Native American (American Indian, Eskimo, Aleut, native Hawaiian); or
- (d) Asian-Pacific American (with origins from Japan, China, the Philippines, Vietnam, Korea, Samoa, Guam, the U.S. Trust Territories of the Pacific, Northern Marianas, Laos, Cambodia, Taiwan or the Indian subcontinent).

(2) In order to satisfy this third criteria of the MBE definition, the minority ownership's interest must be real, substantial and continuing. Such interest is characterized by:

- (a) Risk of loss/share of profit commensurate with the proportional ownership; and
- (b) Receipt of the customary incidents of ownership, such as compensation (i.e., salary and other personnel compensation).

(3) A minority owner must have and exercise control of the business decisions. Characteristics of control include, but are not limited to:

- (a) Authority to sign bids and contracts;
- (b) Decisions in price negotiations;
- (c) Incurring liabilities for the firm;
- (d) Final staffing decisions;
- (e) Policy-making; and
- (f) General company management decisions.

(4) Only those firms performing a useful business function according to custom and practice in the industry, are qualified as MBEs. Acting merely as a passive conduit of funds to some other firm where such activity is unnecessary to accomplish the project does not constitute a "useful business function according to custom and practice in the industry." The purpose of this approach is to discourage the use of MBE "fronts" and limit the creation of an artificial supplier and broker marketplace.

3. Women's Business Enterprise (WBE) is a business which is certified as such by a State or Federal agency, or which meets the following definition:

"A women's business enterprise is an independent business concern which is at least 51 percent owned by a woman or women, who also control and operate it. Determination of whether a business is at least 51 percent owned by a woman or otherwise qualified WBE which is 51 percent owned by a married woman in a community property State will not be disqualified because her husband has a 50 percent interest in her share. Similarly, a business which is 51 percent owned by a married man and 49 percent owned by an

unmarried woman will not become a qualified WBE by virtue of his wife's 50 percent interest in his share of the business."

As in the case of a MBE, only United States citizens will be deemed to be WBEs. Similar to the MBE criteria, WBE should meet the criteria cited in subparagraphs B.1.c.(2), (3), and (4).

4. Fair Share or Fair Share Objective A fair share or a fair share objective is an amount of funds reasonably commensurate with the total project funding and the availability of qualified MBEs and WBEs, taking into account experience on EPA-funded projects and other comparable projects in the area. A fair share objective does not constitute an absolute requirement, but a commitment on the part of the bidder to exercise good faith efforts as defined in this section to use MBEs and WBEs to achieve the fair share objective.
5. Small Business (SBE) Any business entity, including its affiliates, that is independently owned and operated, and not dominant in its field of operations in which it is bidding on Government contracts, and qualified as a small business under the criteria and size standards set forth in 13 CFR Part 121.
6. Small Business in a Rural Area A small business in a rural area (SBRA) is a business entity meeting the definition of a small business, and is located and conducts its principal operations in a geographical area (county) listed in the Small Business Administration's Listing of Non-Metropolitan Counties by State.
7. Recipient A party receiving SRF financial assistance.
8. Project The scope of work for which an SRF loan is awarded.
9. Bidder A party seeking to obtain a contract with a recipient through a competitive, advertised, sealed bid process.
10. Offeror A party seeking to obtain a contract with a recipient through a negotiative procurement process.
11. Prime Contractor A party that has obtained a contract with a recipient through a competitive, advertised, sealed bid process.
12. Good Faith Efforts Good faith efforts by a recipient, prime contractor, and/or bidder/offeror means efforts to attract and utilize DBEs primarily through outreach, recruitment, and race/gender neutral activities. The following are examples of activities to assist recipients, prime contractors and/or bidders/offerors to comply with good faith efforts.
 - a. Include qualified DBEs on solicitation lists.
 - (1) Maintain and update a listing of qualified DBEs that can be solicited for supplies, construction and/or services.
 - (2) Provide listings to all interested parties who requested copies of the bidding or proposing documents.
 - (3) Contact appropriate sources within your geographic area and State to identify qualified DBEs for placement on your minority and women's business listings.
 - (4) Utilize other DBE listings such as those of the State's Minority Business Office, the Small Business Administration, Minority Business Development Agency, US EPA- Office of Small Business Programs and the Department of Transportation.
 - (5) Have the State environmental agency personnel review this solicitation list.

b. Assure that DBEs are solicited.

- (1) Conduct meetings, conferences, and follow-ups with DBEs, small, minority and/or women's business associations, minority media, etc., to inform these groups of opportunities to provide supplies, services, and construction.
- (2) MBE Utilization is facilitated if the recipient or prime contractor advertises through the minority media. Such advertisements may include, but are not limited to, contracting and subcontracting opportunities, hiring and employment, or any other matter related to the project.
- (3) Conduct pre-bid, pre-solicitation, and post-award conferences to ensure that consultants, suppliers, and builders solicit DBEs.
- (4) Provide bidders and offerors with listings of qualified DBEs and establish that a fair share of contracts/procurements should be awarded to these groups.
- (5) Advertise in general circulation, trade publications, State agency publications of identified source, disadvantaged business focused media, etc., concerning contracting opportunities on your projects. Maintain a list of disadvantaged business-focused publications that may be utilized to solicit MBEs or WBEs.
- (6) Provide interested DBEs with adequate information about plans, specifications, timing and other requirements of the proposed projects.
- (7) Provide DBE trade organizations with succinct summaries of solicitations.
- (8) Notify DBEs of future procurement opportunities so that they may establish bidding solicitations and procurement plans.

c. Divide total requirements when economically feasible, into small tasks or quantities to permit maximum participation of DBEs.

- (1) Perform an analysis to identify portions of work that can be divided and performed by qualified DBEs.
- (2) Scrutinize the elements of the total project to develop economically feasible units of work that are within the bonding range of DBEs.
- (3) Analyze bid packages for compliance with the good faith efforts to afford DBEs maximum participation.

d. Establish delivery schedules, where requirements of the work permit, which will encourage participation by DBEs.

- (1) Consider lead times and scheduling requirements often needed by DBE participation.
- (2) Develop realistic delivery schedules which may provide for greater DBE participation.

e. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the US Department of Commerce, as appropriate.

- (1) Use the services of outreach programs sponsored by the Minority Business Development Agency and/or the Small Business Administration to recruit bona fide firms for placement on DBEs' bidders lists to assist these firms in the development of bid packaging.

- (2) Seek out Minority Business Development Centers (MBDCs) to assist recipients and prime contractors in identifying MBEs for potential work opportunities on this project.

D. ADDITIONAL CONTRACT PROVISIONS

1. The prime contractor must pay its subcontractors for satisfactory performance no more than 30 days from the prime contractor's receipt of payment from the owner.
2. The prime contractor must notify the owner in writing prior to any termination of a DBE subcontractor for convenience.
3. If a DBE subcontractor fails to complete work under the subcontract for any reason, the prime contractor must employ the good faith efforts if soliciting a replacement subcontractor, even if the fair share objectives have already been achieved.
4. Each procurement contract signed by an EPA financial recipient, including those for an identified loan under an EPA financial assistance agreement capitalizing a revolving loan fund, must include the following term and condition:

The contractor shall not discriminate on the basis of race, color, national origin or sex in the performance of this contract. The contractor shall carry out applicable requirements of 40 CFR 33 in the award and administration of contracts awarded under EPA financial assistance agreements. Failure by the contractor to carry out these requirements is a material breach of this contract which may result in the termination of this contract or other legally available remedies.

E. REPORTING

1. Bidders/offerors shall demonstrate compliance with good faith efforts in order to be deemed responsible. To demonstrate compliance, the "DBE Subcontractor Solicitation Sheet" (pg. DBE - 6) shall be submitted as part of its bid or proposal package. Information shall be included for each DBE subcontractor contacted by the bidder/offeror, not just those used to meet the fair share objective.
2. The prime contractor must distribute DBE Program Subcontractor Participation Form (Form 6100-2) to all of its DBE subcontractors. The subcontractors can submit completed forms to the South Dakota Department of Agriculture and Natural Resources, Water Resources Assistance Program.
3. The prime contractor must have its DBE subcontractors complete DBE Program Subcontractor Performance Form (Form 6100-3) and should include completed forms in its bid or proposal package.
4. The prime contractor must complete DBE Program Subcontractor Utilization Form (Form 6100-4) which should be submitted as part of its bid or proposal package.
5. Form 6100-3 and Form 6100-4 must be submitted by the apparent low-bidder within ten calendar days of the bid opening. Failure to submit this information will be viewed as a non-responsive bid.

DBE SUBCONTRACTOR SOLICITATION INFORMATION

PROJECT NAME:

Subcontractor Name and Telephone Number	MBE or WBE	Description of Work Offered	Date of Phone Follow-up & Person Contacted	Amount of Bid or Reason for not Quoting	Bid Accepted or Rejected? Include Reason for Rejection

This information is true and correct to the best of my knowledge

Contractor Name, Address and Telephone Number

This form shall be submitted as part of the contractor's bid.

Signature

Title

Date

Disadvantaged Business Enterprise
Program DBE Subcontractor
Participation Form

NAME OF SUBCONTRACTOR¹	PROJECT NAME
ADDRESS	CONTRACT NO.
TELEPHONE NO.	EMAIL ADDRESS
PRIME CONTRACTOR NAME	

Please use the space below to report any concerns regarding the above SRF-funded project (e.g., reason for termination by prime contractor, late payment, etc.).

CONTRACT ITEM NO.	ITEM OF WORK OR DESCRIPTION OF SERVICES RECEIVED FROM THE PRIME CONTRACTOR	AMOUNT SUBCONTRACTOR WAS PAID BY PRIME CONTRACTOR
Subcontractor Signature Title/Date		

¹Subcontractor is defined as a company, firm, Joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an SRF award of financial assistance.

FORM 6100-2 (DBE Subcontractor Participation Form)

**Disadvantaged Business Enterprise Program
DBE Subcontractor Performance Form**

NAME OF SUBCONTRACTOR¹		PROJECT NAME	
ADDRESS		BID/PROPOSAL NO.	
TELEPHONE NO.		E-MAIL ADDRESS	
PRIME CONTRACTOR NAME			
CONTRACT ITEM NO.	ITEM OF WORK OR DESCRIPTION OF SERVICES BID TO PRIME	PRICE OF WORK SUBMITTED TO PRIME CONTRACTOR	
Currently certified as an MBE or WBE under EPA's DBE Program? ☐ Yes ☐ No			
Signature of Prime Contractor		Date	
Print Name		Title	
Signature of Subcontractor		Date	
Print Name		Title	

¹Subcontractor is defined as a company, firm, joint venture, or individual who enters into an agreement with a contractor to provide services pursuant to an SRF award of financial assistance.

FORM 6100-3 (DBE Subcontractor Performance Form)

**Disadvantaged Business Enterprise Program
DBE Subcontractor Utilization Form**

BID/PROPOSAL NO.	PROJECT NAME
NAME OF PRIME BIDDER/PROPOSER	E-MAIL ADDRESS
ADDRESS	
TELEPHONE NO.	FAX NO.

The following subcontractors will be used on this project :			
COMPANY NAME, ADDRESS, PHONE NUMBER, AND E-MAIL ADDRESS	TYPE OF WORK TO BE PERFORMED	ESTIMATED DOLLAR AMOUNT	TYPE OF FIRM? (Print MBE, WBE or None below)
I certify under penalty of perjury that the forgoing statements are true and correct. In the event of a replacement of a subcontractor, I will adhere to the replacement requirements set forth in 40 CFR Part 33 Section 33.302(c)			
_____ Signature of Prime Contractor		_____ Date	
_____ Print Name		_____ Title	

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

FORM 6 100-4 (DBE Subcontractor Utilization Form)

**EQUAL EMPLOYMENT OPPORTUNITY and AFFIRMATIVE ACTION REQUIREMENTS on
FEDERALLY ASSISTED CONSTRUCTION CONTRACTS**

Notice of Requirement for Affirmative Action to Ensure Equal Employment Opportunity

1. The Offer's or Bidder's attention is called to the "Equal Opportunity Clause" and the "Standard Federal Equal Employment Specifications" set forth herein.

2. The goals and timetables for minority and female participation, expressed in percentage terms for the Contractor's aggregate workforce in each trade on all construction work in the covered area as follows:

Goals for minority participation in each trade - _____

(See Appendix A for goals by county)

Goals for female participation in each trade - 6.9%

As used in this notice, and in the contract resulting from this solicitation, the "covered area" is
_____ County.

These goals are applicable to all the contractor's construction work (whether or not it is Federal or Federally assisted) performed in the covered area. If the contractor performs construction work in a geographical area located outside of the covered area, it shall apply the goals established for such geographical area where the work is actually performed. With regard to this second area, the contractor also is subject to the goals for both its federally involved and non-federally involved construction.

The Contractor's compliance with the regulations in 41 CFR Part 60-4 shall be based on its implementation of the Equal Opportunity Clause, specific affirmative action obligations required by the specifications set forth in 41 CFR 60-4.3(a), and its efforts to meet the goals. The hours of minority and female employment and training must be substantially uniform throughout the length of the contract, and in each trade, and the contractor shall make a good faith effort to employ minorities and women evenly on each of its projects. The transfer of minority or female employees or trainees from contractor to contractor or from project to project for the sole purpose of meeting the contractor's goals shall be a violation of the contract and the regulations in 41 CFR Part 60-4. Compliance with the goals will be measured against the total work hours performed.

3. The contractor shall provide written notification to the Director of the Office of Federal Contract Compliance Programs within 10 working days of award of any construction subcontract in excess of \$10,000 at any tier for construction work under the contract resulting from this solicitation. The notification shall list the name, address and telephone number for the subcontractor; employer identification number of the subcontractor; estimated dollar amount of the subcontract; estimated starting and completion dates of the subcontract; and the geographical area in which the contract is to be performed. A form is provided on page EEO - 7 that the contractor may use for this purpose.

This notice shall be included in, and shall be a part of, all solicitations for offers and bids on all federal and federally assisted construction contracts or subcontracts.

EQUAL OPPORTUNITY CLAUSES

The Equal Opportunity Clause published at 41 CFR Part 60-1.4(b) is required to be included in, and is part of, all nonexempt federally assisted construction contracts and subcontracts. The Equal Opportunity Clause shall be considered to be a part of every contract and subcontract required by the regulations in this part to include such a clause, whether or not it is physically incorporated in such contracts.

In addition to the clauses described above, all federal contracting officers, all applicants, and all non-construction contractors, as applicable, shall include the specifications set forth in this section in all federal and federally assisted construction contracts in excess of \$10,000 to be performed in geographical areas designated by the Director pursuant to §60-4.6 of this part and in construction subcontracts in excess of \$10,000 necessary in whole or in part to the performance of non-construction Federal contracts and subcontracts covered.

STANDARD FEDERAL EQUAL EMPLOYMENT OPPORTUNITY CONSTRUCTION CONTRACT SPECIFICATIONS

1. As used in these specifications:

- a. "Covered Area" means the geographical area described in the solicitation from which this contract resulted;
- b. "Director" means Director, Office of Federal Contract Compliance Programs, United States Department of Labor, or any person to whom the Director delegates authority;
- c. "Employer identification number" means the Federal Social Security number used on the employer's quarterly Federal Tax Return, U.S. Treasury Department Form 941.
- d. "Minority" includes:
 - (i) Black (all persons having origins in any of the Black African racial groups not of Hispanic origin);
 - (ii) Hispanic (all persons of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish Culture or origin, regardless of race);
 - (iii) Asian and Pacific Islander (all persons having origins in any of the original peoples of the Far East, Southeast Asia, the Indian Subcontinent, or the Pacific Islands);
 - (iv) American Indian or Alaskan Native (all persons having origins in any of the original peoples of North America and maintaining identifiable tribal affiliations through membership and participation or community identification).

2. Whenever the contractor, or any subcontractor at any tier, subcontracts a portion of the work involving any construction trade, it shall physically include in each subcontract in excess of \$10,000 the provisions of these specifications and the Notice which contains the applicable goals for minority and female participation and which is set forth in the solicitations from which this contract resulted.

3. If the contractor is participating (pursuant to 41 CFR 60-4.5) in a Hometown Plan approved by the U.S. Department of Labor in the covered area either individually or through an association, its affirmative action obligations on all work in the Plan area, (including goals and timetables) shall be in accordance with that Plan for those trades which have unions participating in the Plan. Contractors must be able to demonstrate their participation in and compliance with the provisions of any such Hometown Plan. Each contractor or subcontractor participating in an approved Plan is individually required to comply with its obligations under the EEO clause, and to make a good faith effort to achieve each goal under the Plan in each trade in which it has employees. The overall good faith performance by other contractors or subcontractors toward a goal in an approved Plan does not excuse any covered contractor's or subcontractor's failure to take good faith efforts to achieve the Plan goals and timetables.

4. The contractor shall implement the specific affirmative action standards provided in paragraphs (7)(a) through (p) of these specifications. The goals set forth in the solicitation from which this contract resulted are expressed as percentages of the total hours of employment and training of minority and female utilization the contractor should reasonably be able to achieve in each construction trade in which it has employees in the covered area. Covered Construction contractors performing construction work in geographical areas where they do not have a Federal or federally assisted construction contract shall apply the minority and female goals established for the geographical area where the work is being performed. Goals are published periodically in the FEDERAL REGISTER in notice form, and such notices may be obtained from any Office of Federal Contract Compliance Programs office or from Federal procurement contracting officers. The contractor is expected to make substantially uniform progress toward its goals in each craft during the period specified.

5. Neither the provisions of any collective bargaining agreement, nor the failure by a union with whom the contractor has a collective bargaining agreement, to refer either minorities or women shall excuse the contractor's obligations under these specifications or the regulations promulgated pursuant thereto.

6. In order for the non-working training hours of apprentices and trainees to be counted in meeting the goals, such apprentices and trainees must be employed by the contractor during the training period, and the contractor must have made a commitment to employ the apprentices and trainees at the completion of their training, subject to the availability of employment opportunities. Trainees must be trained pursuant to training programs approved by the U.S. Department of Labor.

7. The contractor shall take specific affirmative actions to ensure equal employment opportunity. The evaluation of the contractor's compliance with these specifications shall be based upon its effort to achieve maximum results from its actions. The contractor shall document these efforts fully, and shall implement affirmative action steps at least as extensive as the following:

a. Ensure and maintain a working environment free of harassment, intimidation, and coercion at all sites, and in all facilities at which the contractor's employees are assigned to work. The contractor, where possible, will assign two or more women to each construction project. The contractor shall specifically ensure that all foremen, superintendents, and other on-site supervisory personnel are aware of and carry out the contractor's obligation to maintain such a working environment, with specific attention to minority or female individuals working at such sites or in such facilities.

b. Establish and maintain a current list of minority and female recruitment sources, provide written notification to minority and female recruitment sources and to community organizations when the contractor or its unions have employment opportunities available, and maintain a record of the organizations' responses.

c. Maintain a current file of the names, addresses, and telephone numbers of each minority and female off-the-street applicant and minority or female referral from a union, a recruitment source or community organization and of what action was taken with respect to each such individual. If such individual was sent to the union hiring hall for referral and was not referred back to the contractor by the union or, if referred, not employed by the contractor, this shall be documented in the file with the reason therefor, along with whatever additional actions the contractor may have taken.

d. Provide immediate written notification to the Director when the union or unions with which the Contractor has a collective bargaining agreement has not referred to the Contractor a minority person or woman sent by the Contractor, or when the Contractor has other information that the union referral process has impeded the Contractor's efforts to meet its obligations.

e. Develop on-the-job training opportunities and/or participate in training programs for the areas which expressly include minorities and women, including upgrading programs and apprenticeship and trainee programs relevant to the contractor's employment needs, especially those programs funded or approved by the Department of Labor. The contractor shall provide notice of these programs to the sources compiled under (7)(b) above.

f. Disseminate the contractor's EEO policy by providing notice of the policy to unions and training programs and requesting their cooperation in assisting the contractor in meeting its EEO obligations; by including it in any policy manual and collective bargaining agreement; by publicizing it in the company newspaper, annual report, etc.; by specific review of the policy with all management personnel and with all minority and female employees at least once a year; and by posting the company EEO policy on bulletin boards accessible to all employees at each location where construction work is performed.

g. Review, at least annually, the company's EEO policy and affirmative action obligations under these specifications with all employees having any responsibility for hiring, assignment, layoff, termination or other employment decisions including specific review of these items with on-site supervisory personnel such as superintendents, general foremen, etc., prior to the initiation of construction work at any job site. A written record shall be made and maintained identifying the time and place of these meetings, persons attending, subject matter discussed, and disposition of the subject matter.

h. Disseminate the contractor's EEO policy externally by including it in any advertising in the news media, specifically including minority and female news media, and providing written notification to and discussing the contractor's EEO policy with other contractors and subcontractors with whom the contractor does or anticipates doing business.

i. Direct its recruitment efforts, both oral and written, to minority, female and community organizations, to schools with minority and female students and to minority and female recruitment and training organizations serving the contractor's recruitment area and employment needs. Not later than one month prior to the date for the acceptance of applications for apprenticeship or other training by any recruitment source, the contractor shall send written notification to organizations such as the above, describing the openings, screening procedures, and tests to be used in the selection process.

j. Encourage present minority and female employees to recruit other minority persons and women and, where reasonable, provide after school, summer and vacation employment to minority and female youth both on the site and in other areas of a contractor's workforce.

k. Validate all tests and other selection requirements where there is an obligation to do so under 41 CFR Part 60-3.

l. Conduct, at least annually, an inventory and evaluation at least of all minority and female personnel for promotional opportunities and encourage these employees to seek or to prepare for, through appropriate training, etc., such opportunities.

m. Ensure that seniority practices, job classifications, work assignments and other personnel practices, do not have a discriminatory effect by continually monitoring all personnel and employment related activities to ensure that the EEO policy and the contractor's obligations under these specifications are being carried out.

n. Ensure that all facilities and company activities are non-segregated except that separate or single-user toilet and necessary changing facilities shall be provided to assure privacy between the sexes.

o. Document and maintain a record of all solicitations of offers for subcontracts from minority and female construction contractors and suppliers, including circulation of solicitations to minority and female contractor associations and other business associations.

p. Conduct a review, at least annually, of all supervisor's adherence to and performance under the contractor's EEO policies and affirmative action obligations.

8. Contractors are encouraged to participate in voluntary associations which assist in fulfilling one or more of their affirmative action obligations (7)(a) through (p). The efforts of a contractor association, joint contractor-union, contractor-community, or other similar group of which the contractor is a member and participant, may be

asserted as fulfilling any one or more of its obligations under (7)(a) through (p) of these specifications provided that the contractor actively participates in the group, makes every effort to assure that the group has positive impact on the employment of minorities and women in the industry, ensures that the concrete benefits of the program are reflected in the contractor's minority and female workforce participation, makes a good faith effort to meet its individual goals and timetables, and can provide access to documentation which demonstrates the effectiveness of actions taken on behalf of the contractor. The obligation to comply, however, is the contractor's and failure of such a group to fulfill an obligation shall not be a defense for the contractor's noncompliance.

9. A single goal for minorities and a separate single goal for women have been established. The contractor, however, is required to provide equal employment opportunity and to take affirmative action for all minority groups, both male and female, and all women, both minority and non-minority. Consequently, the contractor may be in violation if a particular group is employed in a substantially disparate manner (for example, even though the contractor has achieved its goals for women generally, the contractor may be in violation if a specific minority group of women is under-utilized).

10. The contractor shall not use the goals and timetables of affirmative action standards to discriminate against any person because of race, color, religion, sex, or national origin.

11. The contractor shall not enter into any subcontract with any person or firm debarred from government contracts.

12. The contractor shall carry out such sanctions and penalties for violation of these specifications and of the Equal Opportunity Clause, including suspension, termination and cancellation of existing subcontracts as may be imposed or ordered, and its implementing regulations, by the Office of Federal Contract Compliance Programs. Any contractor who fails to carry out such sanctions and penalties shall be in violation of these specifications.

13. The contractor, in fulfilling its obligations under these specifications, shall implement specific affirmative action steps, at least as extensive as those standards prescribed in paragraph (7) of these specifications, so as to achieve maximum results from its efforts to ensure equal employment opportunity. If the contractor fails to comply with the requirements of the implementing regulations or these specifications, the Director shall proceed in accordance with 41 CFR 60-4.8.

14. The contractor shall designate a responsible official to monitor all employment related activity to ensure that the company EEO policy is being carried out, to submit reports relating to the provisions hereof as may be required by the government and to keep records. Records shall at least include for each employee the name, address, telephone numbers, construction trade, union affiliation if any, employee identification number when assigned, social security number, race, sex, status (e.g., mechanic, apprentice, trainee, helper, or laborer), dates of changes in status, hours worked per week in the indicated trade, rate of pay, and locations at which the work was performed. Records shall be maintained in an easily understandable and retrievable form; however, to the degree that existing records satisfy this requirement, contractors shall not be required to maintain separate records.

15. Nothing herein provided shall be construed as a limitation upon the application of other laws which establish different standards of compliance or upon the application of requirements for the hiring of local or other area residents (e.g., those under the Public Works Employment Act of 1977 and the Community Development Block Grant Program).

16. The contractor shall ensure compliance with all civil rights laws. These include but may not be limited to 1) Age Discrimination Act of 1975, 2) Section 13 of the FWPCA Amendments of 1972, 3) Section 504 of the Rehabilitation Act of 1973, and 4) Title VI of the Civil Rights Act of 1964.

APPENDIX A

GOALS FOR MINORITY PARTICIPATION ON EACH TRADE

Counties	Goal
Aurora, Beadle, Brookings, Brule, Charles Mix, Davison, Douglas, Gregory, Hand, Hanson, Hutchinson, Jerauld, Kingsbury, Lake, Lincoln (excluding Sioux Falls), McCook, Miner, Moody, Sanborn, Turner	0.8
Bon Homme, Clay, Minnehaha (including all of Sioux Falls), Union, Yankton	1.2
Brown, Clark, Codington, Day, Deuel, Edmunds, Faulk, Grant, Hamlin, McPherson, Marshall, Roberts, Spink	1.3
Meade, Pennington	3.4
Bennett, Buffalo, Butte, Campbell, Corson, Custer, Dewey, Fall River, Haakon, Harding, Hughes, Hyde, Jackson, Jones, Lawrence, Lyman, Mellette, Perkins, Potter, Shannon, Stanley, Sully, Todd, Tripp, Walworth, Ziebach	7.9

CONTRACTOR'S NAME, ADDRESS & TELEPHONE NUMBER

Contractor Employer ID Number:

Return to:

Joan Ford, Regional Director
US Department of Labor
Federal Building, Room 840
525 South Griffin St.
Dallas, TX 75202

CONTRACT INFORMATION

PROJECT AND LOCATION:				
Dollar Amount of Contract	Estimated Start Date	Estimated Completion Date	Contract No.	Geographical Area (County, State)

NOTIFICATION OF SUBCONTRACTS AWARDED (>\$10,000)

Subcontractor's Name Address, and Phone Number	Employer ID Number of Subcontractor	Estimated \$ Amount of Subcontract	Estimated Start Date	Estimated Completion Date

CERTIFICATION REGARDING DEBARMENT, SUSPENSION, AND OTHER RESPONSIBILITY MATTERS

A. INSTRUCTIONS

Under Executive Order 12549, an individual or organization debarred or excluded from participation in Federal assistance or benefit programs may not receive any assistance award under a Federal program, or a sub-agreement thereunder for \$25,000 or more. The status of prospective individuals or organizations can be checked at:

<http://epls.arnet.gov/>

Accordingly, each prospective recipient of an EPA grant, loan, or cooperative agreement and any contract or sub-agreement participant thereunder must complete the attached certification or provide an explanation why they cannot complete the certification. For further details, see 40 CFR 32.510, Participants Responsibilities.

B. WHERE TO SUBMIT

A prospective prime contractor must submit a completed certification or explanation to the project owner for the project. Each prospective subcontractor must submit a completed certification or explanation to the prime contractor for the project.

C. HOW TO OBTAIN FORMS

This form may be reproduced as necessary. If needed, additional forms may be obtained from the Department of Agriculture and Natural Resources.

SRF Project Number

United States Environmental Protection Agency
Washington, DC 20460

**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 judgement 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 (1)(b) of this certification; and
- (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State, or local) terminated for cause or default.

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.

Typed Name & Title of Authorized Representative

Signature of Authorized Representative

Date

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

PROHIBITION AGAINST LISTED VIOLATED FACILITIES

A. REQUIREMENTS

- (1) To comply with all the requirements of section 114 of the Clean Air Act, as amended (42 U.S.C. 1857, et seq., as amended by Pub. L. 92-604) and section 308 of the Clean Water Act (33 U.S.C. 1251, as amended), respectively, which relate to inspection, monitoring, entry, reports, and information, as well as other requirements specified in section 114 and section 308 of the Air Act and the Water Act, respectively, and all regulations and guidelines issued thereunder before the award of this contract.
- (2) That no portion of the work required by this prime contract will be performed in a facility listed on the Environmental Protection Agency list of violating facilities on the date when this contract was awarded unless and until the EPA eliminates the name of such facility or facilities from the listing.
- (3) That the best efforts to comply with clean air and clean water standards at the facilities in which the contract is being performed.
- (4) To insert the substance of the provisions of this clause, including this paragraph (4), in any nonexempt subcontract.

B. DEFINITIONS

- (1) Air Act means the Clean Air Act, as amended (42 U.S.C. 1857 et seq.).
- (2) Water Act means the Clean Water Act, as amended (33 U.S.C. 1251 et seq.).
- (3) Clean Air Standards means any enforceable rules, regulations, guidelines, standards, limitations, orders, controls, prohibitions, or other requirements which are contained in, issued under, or otherwise adopted under the Air Act or Executive Order 11738, an applicable implementation plan as described in section 110 (d) of the Air Act (42 U.S.C. 1857c-5(d)), an approved implementation procedure or plan under section 111 (c) or section 111(d), or an approved implementation procedure under section 112(d) of the Air Act (42 U.S.C. 1857c-7(d)).
- (4) Clean Water Standards means any enforceable limitation, control, condition, prohibition, standard, or other requirement which is promulgated under the Water Act or contained in a permit issued to a discharger by the Environmental Protection Agency or by a State under an approved program, as authorized by section 402 of the Water Act (33 U.S.C. 1342), or by a local government to ensure compliance with pretreatment regulations as required by section 307 of Water Act (33 U.S.C. 1317).
- (5) Compliance means compliance with clean air or water standards. Compliance shall also mean compliance with a schedule or plan ordered or approved by a court of competent jurisdiction, the Environmental Protection Agency in accordance with the requirements of the Air Act or Water Act and regulations.
- (6) Facility means any building, plant, installation, structure, mine, vessel, or other floating craft, location, or site of operations, owned, leased, or supervised by a contractor or subcontractor, to be used in the performance of a contract or subcontract. Where a location or site of operations contains or includes more than one building, plant, installation, or structure, the entire location or site shall be deemed to be a facility except where the Director, Office of Federal Activities, Environmental Protection Agency, determines that independent facilities are located in one geographical area.

WILLIAMS-STEIGER OCCUPATIONAL SAFETY AND HEALTH ACT OF 1970

A. AUTHORITY

- (1) The contractor is subject to the provisions of the Williams-Steiger Occupational Safety and Health Act of 1970.
- (2) These construction documents and the joint and several phases of construction hereby contemplated are to be governed, at all times, by applicable provisions of the Federal law(s) , including but not limited to the latest amendment of the following:
 - a. Williams-Steiger Occupational Safety and Health Act of 1970, Public Law 94-596;
 - b. Part 1910 - Occupational Safety and Health Standards, Chapter XVII of Title 29, Code of Federal Regulations;
 - c. Part 1926 - Safety and Health Regulations for Construction, Chapter XVII of Title 29, Code of Federal Regulations.

B. SAFETY AND HEALTH PROGRAM REQUIREMENTS

- (1) This project, its prime contractor and its subcontractors, shall at all times be governed by Chapter XVII of Title 29, Code of Federal Regulations, Part 1926 - Safety and Health Regulations for Construction (29 CFR 22801), as amended to date.
- (2) To implement the program and to provide safe and healthful working conditions for all persons, general project safety meetings will be conducted at the site at least once each month during the course of construction, by the construction superintendent or his/her designated safety officer. Notice of such meeting shall be issued not less than three (3) days prior, stating the exact time, location, and agenda to be included. Attendance by the owner, architect, general foreman, shop steward(s), and trades, or their designated representatives, witnessed in writing as such, shall be mandatory.
- (3) To further implement the program, each trade shall conduct a short gang meeting, not less than once a week, to review project safety requirements mandatory for all persons during the coming week. The gang foreman shall report the agenda and specific items covered to the project superintendent, who shall incorporate these items in his/her daily log or report.
- (4) The prime contractor and all subcontractors shall immediately report all accidents, injuries, or health hazards to the owner and architect, or their designated representatives, in writing. This shall not obviate any mandatory reporting under the provisions of the Occupational Safety and Health Act of 1970.
- (5) This program shall become a part of the contract documents and the contract between the owner and prime contractor, prime contractor and all subcontractors, as though fully written therein.

DISCOVERY OF ARCHAEOLOGICAL AND OTHER HISTORICAL ITEMS

In the event of an archaeological find during any phase of construction, the following procedure will be followed:

- (1) Construction shall be halted, with as little disruption to the archaeological site as possible.
- (2) The Contractor shall notify the Owner who shall contact the State Historical Preservation Officer.
- (3) The State Historical Preservation Officer may decide to have an archaeologist inspect the site and make recommendations about the steps needed to protect the site, before construction is resumed.
- (4) The entire event should be handled as expediently as possible in order to hold the loss in construction time to a minimum while still protecting archaeological finds.

A similar procedure should be followed with regard to more recent historical resources. Should any artifacts, housing sites, etc., be uncovered, the same procedure should be followed as for an archaeological find.

In the event archaeological/historical data are evaluated to meet National Register criteria, the Advisory Council on Historic Preservation may be notified and asked to comment by the South Dakota Department of Agriculture and Natural Resources.

DAVIS-BACON AND RELATED ACTS

LABOR STANDARDS

Contractors performing work on construction projects which have been provided assistance through the State Revolving Fund must fulfill the requirements of the Labor Standards Provisions for federally assisted construction contracts. These standards are located at the end of this section.

WEEKLY CONTRACTOR PAYROLLS

Each week as work progresses, the contractor must submit to the Owner a copy of all weekly payrolls and required attachments stipulated therein. Sample suggested payrolls may be obtained from the Owner upon request. All weekly payrolls shall contain or have attached the following:

1. Name of each employee and the last four digits of the social security number.
2. Classification of employees (same as shown on wage determination).
3. Rate of pay not less than that shown on the wage determination.
4. Hours worked each day and total for each week for each employee.
5. All deductions made.
6. Net amount paid to employee.
7. The following certification:

"I certify that the payroll is correct and complete, that the wage rates contained therein are not less than the applicable rates contained in the Wage Determination decision of the Secretary of Labor and that the classification set forth for each laborer or mechanic conform with the work he performs."

(Signature)

(Title)

COMPLIANCE WITH THE COPELAND (ANTI-KICKBACK) ACT

The following anti-kickback statement must be submitted with each set of weekly payrolls:

"I, (name of signatory party), (title), do hereby state: That I pay or supervise the payment of the persons employed by (contractor or subcontractor) on the (work or building); that during the payroll period commencing on the _____ day of _____, 20____, and ending the _____ day of _____, 20____, all persons employed on said project have been paid the full weekly wages earned, that no rebates have been or will be made either directly or indirectly from the full weekly wages earned by any person, other than permissible deductions, as defined in Regulations, Part 3 (CFR Part 3) issued by the Secretary of Labor under the Copeland Act, as amended (48 Stat. 948; 63 Stat. 108; 72 Stat. 967; and 40 U.S.C. 276c), and described below: (Paragraph describing deductions, if any)"

(Signature)

(Title)

All prime contractors shall include the wage determination and all the labor standards provisions in all subcontracts as herein specified.

The Contractor shall make employment records available for inspection by authorized representatives of the State of South Dakota and the Department of Labor, and will permit employees to be interviewed during working hours by these representatives. Payroll records will be maintained during the course of the work by the Prime Contractor, including a copy of the payroll of each Subcontractor and they shall be preserved for a period of three years thereafter.

Each monthly engineering estimate must be accompanied by the following certificate executed by each Prime Contractor employing mechanics and laborers at the site on work in which the Federal government is to participate:

Principal Contractor _____

Project Name _____

Project No. _____

I, _____, as official representative of the above named principal contractor do hereby certify as follows:

- ☐ All Labor Standards Requirements have been fulfilled by principal contractor and all subcontractors under this contract; or
- ☐ There is an honest dispute regarding the required provisions.

Explanation: _____

(Signature)

(Title)

In the event of a violation of the Labor Standards provisions of the contract by the Prime Contractor or any Subcontractor, the owner may, after notice to the Contractor, suspend further payments or proceed to terminate the contract as provided in the Labor Standards section of the Contract.

FEDERAL LABOR STANDARDS PROVISIONS

Applicability

The Project or Program to which the construction work covered by this contract pertains is being assisted by the United States of America and the following Federal Labor Standards Provisions are included in this Contract pursuant to the provisions applicable to such Federal assistance.

A.1 Minimum Wages

(i) All laborers and mechanics employed or working upon the site of the work will be paid unconditionally and not less often than once a week, and without payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act(29CFR Part 3), the full amount of wages and bona fide fringe benefits(or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics. Contributions made or costs reasonably anticipated for bona fide fringe benefits under Section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of 29 CFR 5.5(a)(1)(iv); also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs, which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in 29 CFR Part 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein; Provided, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under 29 CFR Part 5.5(a)(1)(ii) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)(a) Any class of laborers or mechanics which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. EPA shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

- (3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.
- (b) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and EPA or its designee agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by EPA or its designee to the Administrator of the Wage and Hour Division, Employment standards Administration, U.S. Department of Labor, Washington, D.C. 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise EPA or its designee or will notify EPA or its designee within the 30-day period that additional time is necessary. (Approved by the Office of Management and Budget under OMB control number 1215-0140.)
- (c) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and EPA or its designee do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits where appropriate), EPA or its designee shall refer the questions, including the views of all interested parties and the recommendation of EPA or its designee, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise EPA or its designee or will notify EPA or its designee within the 30-day period that additional time is necessary. (Approved by the Office of Management and Budget under OMB control Number 1215-0140.)
- (d) The wage rate (including fringe benefits where appropriate) determined pursuant to subparagraphs (1)(b) or (c) of this paragraph, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.
- (iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.
- (iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program. (Approved by the Office of Management and Budget under OMB Control Number 1215-0140.)

2. Withholding.

EPA or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other Federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the

event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work, all or part of the wages required by the contract, EPA or its designee may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased. EPA or its designee may, after written notice to the contractor, disburse such amounts withheld for and on account of the contractor or subcontractor to the respective employees to whom they are due. The Comptroller General shall make such disbursements in the case of direct Davis-Bacon Act contracts.

3. Payrolls and basic records

(i) Basic records relating thereto shall be maintained by the contractor during the course of the work preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work. Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents there of the types described in Section 1(b)(2)B of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Certified weekly payrolls shall contain the name and last four digits of the social security number. Whenever the Secretary of Labor has found under 29 CFR 5.5 (a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in Section 1(b)(2)(b) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs. (Approved by the Office of Management and Budget under OMB control Numbers 1215-0140 and 1215-0017.)

(ii)(a) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to EPA or its designee if the agency is a party to the contract, but if the agency is not such party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to EPA or its designee. The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR Part 5.5(a)(3)(i). This information may be submitted in any form desired. Optional Form WH-347 is available for this purpose and may be purchased from the Superintendent of documents (Federal Stock Number 029-005-00014-1), U.S. Government Printing Office, Washington, D.C. 20402. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. (Approved by the Office of management and Budget under OMB Control Number 1215-0149.)

(b) Each payroll submitted shall be accompanied by a "Statement of compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

That the payroll for the payroll period contains the information required to be maintained under 29 CFR Part 5.59(a)(3)(i) and that such information is correct and complete;

That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in 29 CFR Part 3.

That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

- (c) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of compliance" required by paragraph A.3(ii)(b) of this section.
- (d) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under Section 1001 of Title 18 and Section 231 of Title 31 of the United States Code.
- (iii) The contractor or subcontractor shall make the records required under paragraph A.3(i) of this section available for inspection, copying, or transcription by authorized representatives of EPA or its designee or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, EPA or its designee may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR Part 5.12.

4. **Apprentices and trainees.**

- (i) **Apprentices.** Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Bureau of Apprenticeship and Training, or with a State Apprenticeship Agency recognized by the Bureau, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program who is not individually registered in the program, but who has been certified by the Bureau of Apprenticeship and Training or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program

for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevail for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the bureau of Apprenticeship and Training, or a State Apprenticeship Agency recognized by the Bureau, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) **Trainees.** Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) **Equal employment opportunity.** The utilization of apprentices, trainees, and journeymen under this part shall be in conformity with the equal and employment opportunity requirements of executive order 11246, as amended, and 29 CFR Part 30.

5. **Compliance with Copeland Act requirements.** The contractor shall comply with the requirements of 29 CFR Part 3, which are incorporated by reference in this contract.
6. **Subcontracts.** The contractor or subcontractor will insert in any subcontracts the clauses contained in 29 CFR 5.5 (a)(1) through (10) and such other clauses as EPA or its designee may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR Part 5.5.
7. **Contract termination; debarment.** A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

8. **Compliance with Davis-Bacon and Related Act Requirements.** All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR Parts 1, 3, and 5 are herein incorporated by reference in this contract.
9. **Disputes concerning labor standards.** Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR Parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and EPA or its designee, the U.S. Department of Labor, or the employees or their representatives.

10. **Certification of Eligibility**

- (i). By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1) or to be awarded EPA contracts or participate in EPA programs pursuant to 24 CFR Part 24.
- (ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of Section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1) or to be awarded EPA contracts or participate in EPA programs pursuant to 24 CFR Part 24.
- (iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001. Additionally, U.S. Criminal Code, Section 1010, Title 18, U.S.C., "Federal Housing Administration transactions", provides in part "Whoever, for the purpose of...influencing in any way the action of such Administration...makes, utters or publishes any statement, knowing the same to be false...shall be fined not more than \$5,000 or imprisoned not more than two years or both."

11. **Complaints, Proceedings, or Testimony by Employees.** No laborer or mechanic to whom the wage, salary, or other labor standards provisions of this Contract are applicable shall be discharged or in any other manner discriminated against by the Contractor or any subcontractor because such employee has filed any complaint or instituted or caused to be instituted any proceeding or has testified or is about to testify in any proceeding under or relating to the labor standards applicable under this Contract to his employer.

- B. **Contract Work Hours and Safety Standards Act.** As used in this paragraph, the terms "laborers" and "mechanics" include watchmen and guards.

Overtime requirements. No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek, whichever is greater.

Violation: liability for unpaid wages: liquidated damages. In the event of any violation of the clause set forth in subparagraph (1) of this paragraph, the contractor and any subcontractor responsible therefore shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic

including watchmen and guards, employed in violation of the clause set forth in subparagraph (1) of this paragraph in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in subparagraph (1) of this paragraph.

Withholding for unpaid wages and liquidated damages. EPA or its designee shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contract or any other Federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in subparagraph (2) of this paragraph.

Subcontracts. The contractor or subcontractor shall insert in any subcontracts the clauses set forth in subparagraph (1) through (4) of this paragraph and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in subparagraphs (1) through (4) of this paragraph.

C. **Health and Safety**

No laborer or mechanic shall be required to work in surroundings or under working conditions which are unsanitary, hazardous, or dangerous to his health and safety as determined under construction safety and health standards promulgated by the Secretary of Labor by regulation.

The Contractor shall comply with all regulations issued by the Secretary of Labor pursuant to Title 29 Part 1926 (formerly part 1518) and failure to comply may result in imposition of sanctions pursuant to the Contract Work Hours and Safety Standards Act (Public Law 91-54,83 Stat.96).

The Contractor shall include the provisions of this Article in every subcontract so that such provisions will be binding on each subcontractor. The Contractor shall take such action with respect to any subcontract as the Administrator of Agriculture and Natural Resources or the Secretary of Labor shall direct as a means of enforcing such provisions.



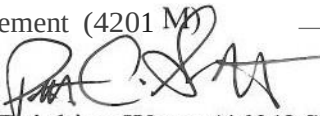
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

MARCH 20 2014

OFFICE OF WATER

MEMORANDUM

SUBJECT: Implementation of American Iron and Steel provisions of P.L. 113-76, Consolidated Appropriations Act, 2014

FROM: (Andrew D. Sawyers, Director
Office of Wastewater Management (4201M) _____
Peter C. Grevatt, Director 
Office of Ground Water and Drinking Water (4601M)

TO: Water Management Division Directors
Regions I- X

P.L. 113-76, Consolidated Appropriations Act, 2014 (Act), includes an "American Iron and Steel (AIS)" requirement in section 436 that requires Clean Water State Revolving Loan Fund (CWSRF) and Drinking Water State Revolving Loan Fund (DWSRF) assistance recipients to use iron and steel products that are produced in the United States for projects for the construction, alteration, maintenance, or repair of a public water system or treatment works if the project is funded through an assistance agreement executed beginning January 17, 2014 (enactment of the Act), through the end of Federal Fiscal Year 2014.

Section 436 also sets forth certain circumstances under which EPA may waive the AIS requirement. Furthermore, the Act specifically exempts projects where engineering plans and specifications were approved by a State agency prior to January 17, 2014.

The approach described below explains how EPA will implement the AIS requirement. The first section is in the form of questions and answers that address the types of projects that must comply with the AIS requirement, the types of products covered by the AIS requirement, and compliance. The second section is a step-by-step process for requesting waivers and the circumstances under which waivers may be granted.

Implementation

The Act states:

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

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

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

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

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

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

(c) If the Administrator receives a request for a waiver under this section, the Administrator shall make available to the public on an informal basis a copy of the request and information available to the Administrator concerning the request, and shall allow for informal public input on the request for at least 15 days prior to making a finding based on the request. The Administrator shall make the request and accompanying information available by electronic means, including on the official public Internet Web site of the Environmental Protection Agency.

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

(e) The Administrator may retain up to 0.25 percent of the funds appropriated in this Act for the Clean and Drinking Water State Revolving Funds for carrying out

the provisions described in subsection (a)(1) for management and oversight of the requirements of this section.

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

The following questions and answers provide guidance for implementing and complying with the AIS requirements:

Project Coverage

1) What classes of projects are covered by the AIS requirement?

All treatment works projects funded by a CWSRF assistance agreement, and all public water system projects funded by a DWSRF assistance agreement, from the date of enactment through the end of Federal Fiscal Year 2014, are covered. The AIS requirements apply to the entirety of the project, no matter when construction begins or ends. Additionally, the AIS requirements apply to all parts of the project, no matter the source of funding.

2) Does the AIS requirement apply to nonpoint source projects or national estuary projects?

No. Congress did not include an AIS requirement for nonpoint source and national estuary projects unless the project can also be classified as a 'treatment works' as defined by section 212 of the Clean Water Act.

3) Are any projects for the construction, alteration, maintenance, or repair of a public water system or treatment works excluded from the AIS requirement?

Any project, whether a treatment works project or a public water system project, for which engineering plans and specifications were approved by the responsible state agency prior to January 17, 2014, is excluded from the AIS requirements.

4) What if the project does not have approved engineering plans and specifications but has signed an assistance agreement with a CWSRF or DWSRF program prior to January 17, 2014?

The AIS requirements do not apply to any project for which an assistance agreement was signed prior to January 17, 2014.

5) What if the project does not have approved engineering plans and specifications, but bids were advertised prior to January 17, 2014 and an assistance agreement was signed after January 17, 2014?

If the project does not require approved engineering plans and specifications, the bid advertisement date will count in lieu of the approval date for purposes of the exemption in section 436(f).

6) What if the assistance agreement that was signed prior to January 17, 2014, only funded a part of the overall project, where the remainder of the project will be funded later with another SRF loan?

If the original assistance agreement funded any construction of the project, the date of the original assistance agreement counts for purposes of the exemption. If the original assistance agreement was only for planning and design, the date of that assistance agreement will count for purposes of the exemption only if there is a written commitment or expectation on the part of the assistance recipient to fund the remainder of the project with SRF funds.

7) What if the assistance agreement that was signed prior to January 17, 2014, funded the first phase of a multi-phase project, where the remaining phases will be funded by SRF assistance in the future?

In such a case, the phases of the project will be considered a single project if all construction necessary to complete the building or work, regardless of the number of contracts or assistance agreements involved, are closely related in purpose, time and place. However, there are many situations in which major construction activities are clearly undertaken in phases that are distinct in purpose, time, or place. In the case of distinct phases, projects with engineering plans and specifications approval or assistance agreements signed prior to January 17, 2014 would be excluded from AIS requirements while those approved/signed on January 17, 2014, or later would be covered by the AIS requirements.

8) What if a project has split funding from a non-SRF source?

Many States intend to fund projects with “split” funding, from the SRF program and from State or other programs. Based on the Act language in section 436, which requires that American iron and steel products be used in any project for the construction, alteration, maintenance, or repair of a public water system or treatment works receiving SRF funding between and including January 17, 2014 and September 30, 2014, any project that is funded in whole or in part with such funds must comply with the AIS requirement. A “project” consists of all construction necessary to complete the building or work regardless of the number of contracts or assistance agreements involved so long as all contracts and assistance agreements awarded are closely related in purpose, time and place. This precludes the intentional splitting of SRF projects into separate and smaller contracts or assistance agreements to avoid AIS coverage on some portion of a

larger project, particularly where the activities are integrally and proximately related to the whole. However, there are many situations in which major construction activities are clearly undertaken in separate phases that are distinct in purpose, time, or place, in which case, separate contracts or assistance agreement for SRF and State or other funding would carry separate requirements.

9) What about refinancing?

If a project began construction, financed from a non-SRF source, prior to January 17, 2014, but is refinanced through an SRF assistance agreement executed on or after January 17, 2014 and prior to October 1, 2014, AIS requirements will apply to all construction that occurs on or after January 17, 2014, through completion of construction, unless, as is likely, engineering plans and specifications were approved by a responsible state agency prior to January 17, 2014. There is no retroactive application of the AIS requirements where a refinancing occurs for a project that has completed construction prior to January 17, 2014.

10) Do the AIS requirements apply to any other EPA programs, besides the SRF program, such as the Tribal Set-aside grants or grants to the Territories and DC?

No, the AIS requirement only applies to funds made available by a State water pollution control revolving fund as authorized by title VI of the Federal Water Pollution Control Act (33 U.S.C. 1381 et seq.) or made available by a drinking water treatment revolving loan fund as authorized by section 1452 of the Safe Drinking Water Act (42 U.S.C. 300j-12)

Covered Iron and Steel Products

11) What is an iron or steel product?

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

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

12) What does the term ‘primarily iron or steel’ mean?

‘Primarily iron or steel’ places constraints on the list of products above. For one of the listed products to be considered subject to the AIS requirements, it must be made of greater than 50% iron or steel, measured by cost. The cost should be based on the material costs.

13) Can you provide an example of how to perform a cost determination?

For example, the iron portion of a fire hydrant would likely be the bonnet, body and shoe, and the cost then would include the pouring and casting to create those components. The other material costs would include non-iron and steel internal workings of the fire hydrant (i.e., stem, coupling, valve, seals, etc). However, the assembly of the internal workings into the hydrant body would not be included in this cost calculation. If one of the listed products is not made primarily of iron or steel, United States (US) provenance is not required. An exception to this definition is reinforced precast concrete, which is addressed in a later question.

14) If a product is composed of more than 50% iron or steel, but is not listed in the above list of items, must the item be produced in the US? Alternatively, must the iron or steel in such a product be produced in the US?

The answer to both question is no. Only items on the above list must be produced in the US. Additionally, the iron or steel in a non-listed item can be sourced from outside the US.

15) What is the definition of steel?

Steel means an alloy that includes at least 50 percent iron, between .02 and 2 percent carbon, and may include other elements. Metallic elements such as chromium, nickel, molybdenum, manganese, and silicon may be added during the melting of steel for the purpose of enhancing properties such as corrosion resistance, hardness, or strength. The definition of steel covers carbon steel, alloy steel, stainless steel, tool steel and other specialty steels.

16) What does ‘produced in the United States’ mean?

Production in the United States of the iron or steel products used in the project requires that all manufacturing processes, including application of coatings, must take place in the United States, with the exception of metallurgical processes involving refinement of steel additives. All manufacturing processes includes processes such as melting, refining, forming, rolling, drawing, finishing, fabricating and coating. Further, if a domestic iron and steel product is taken out of the US for any part of the manufacturing process, it becomes foreign source material. However, raw materials such as iron ore, limestone and iron and steel scrap are not covered by the AIS requirement, and the

material(s), if any, being applied as a coating are similarly not covered. Non-iron or steel components of an iron and steel product may come from non-US sources. For example, for products such as valves and hydrants, the individual non-iron and steel components do not have to be of domestic origin.

17) Are the raw materials used in the production of iron or steel required to come from US sources?

No. Raw materials, such as iron ore, limestone, scrap iron, and scrap steel, can come from non-US sources.

18) If an above listed item is primarily made of iron or steel, but is only at the construction site temporarily, must such an item be produced in the US?

No. Only the above listed products made primarily of iron or steel, permanently incorporated into the project must be produced in the US. For example trench boxes, scaffolding or equipment, which are removed from the project site upon completion of the project, are not required to be made of U.S. Iron or Steel.

19) What is the definition of ‘municipal castings’?

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

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

Meter Boxes;
Service Boxes;
Steel Hinged Hatches, Square and Rectangular;
Steel Riser Rings;
Trash receptacles;
Tree Grates;
Tree Guards;
Trench Grates; and
Valve Boxes, Covers and Risers.

20) What is ‘structural steel’?

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

21) What is a ‘construction material’ for purposes of the AIS requirement?

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

22) What is not considered a ‘construction material’ for purposes of the AIS requirement?

Mechanical and electrical components, equipment and systems are not considered construction materials. Mechanical equipment is typically that which has motorized parts and/or is powered by a motor. Electrical equipment is typically any machine powered by electricity and includes components that are part of the electrical distribution system.

The following examples (including their appurtenances necessary for their intended use and operation) are NOT considered construction materials: pumps, motors, gear reducers, drives (including variable frequency drives (VFDs)), electric/pneumatic/manual accessories used to operate valves (such as electric valve actuators), mixers, gates, motorized screens (such as traveling screens), blowers/aeration equipment, compressors, meters, sensors, controls and switches, supervisory control and

data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, clarifiers and clarifier mechanisms, rakes, grinders, disinfection systems, presses (including belt presses), conveyors, cranes, HVAC (excluding ductwork), water heaters, heat exchangers, generators, cabinetry and housings (such as electrical boxes/enclosures), lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, analytical instrumentation, and dewatering equipment.

23) If the iron or steel is produced in the US, may other steps in the manufacturing process take place outside of the US, such as assembly?

No. Production in the US of the iron or steel used in a listed product requires that all manufacturing processes must take place in the United States, except metallurgical processes involving refinement of steel additives.

24) What processes must occur in the US to be compliant with the AIS requirement for reinforced precast concrete?

While reinforced precast concrete may not be at least 50% iron or steel, in this particular case, the reinforcing bar and wire must be produced in the US and meet the same standards as for any other iron or steel product. Additionally, the casting of the concrete product must take place in the US. The cement and other raw materials used in concrete production are not required to be of domestic origin.

If the reinforced concrete is cast at the construction site, the reinforcing bar and wire are considered to be a construction material and must be produced in the US.

Compliance

25) How should an assistance recipient document compliance with the AIS requirement?

In order to ensure compliance with the AIS requirement, specific AIS contract language must be included in each contract, starting with the assistance agreement, all the way down to the purchase agreements. Sample language for assistance agreements and contracts can be found in Appendix 3 and 4.

EPA recommends the use of a step certification process, similar to one used by the Federal Highway Administration. The step certification process is a method to ensure that producers adhere to the AIS requirement and assistance recipients can verify that products comply with the AIS requirement. The process also establishes accountability and better enables States to take enforcement actions against violators.

Step certification creates a paper trail which documents the location of the manufacturing process involved with the production of steel and iron materials. A step certification is a process under which each handler (supplier, fabricator, manufacturer,

processor, etc) of the iron and steel products certifies that their step in the process was domestically performed. Each time a step in the manufacturing process takes place, the manufacturer delivers its work along with a certification of its origin. A certification can be quite simple. Typically, it includes the name of the manufacturer, the location of the manufacturing facility where the product or process took place (not its headquarters), a description of the product or item being delivered, and a signature by a manufacturer's responsible party. Attached, as Appendix 5, are sample certifications. These certifications should be collected and maintained by assistance recipients.

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

26) How should a State ensure assistance recipients are complying with the AIS requirement?

In order to ensure compliance with the AIS requirement, States SRF programs must include specific AIS contract language in the assistance agreement. Sample language for assistance agreements can be found in Appendix 3.

States should also, as a best practice, conduct site visits of projects during construction and review documentation demonstrating proof of compliance which the assistance recipient has gathered.

27) What happens if a State or EPA finds a non-compliant iron and/or steel product permanently incorporated in the project?

If a potentially non-compliant product is identified, the State should notify the assistance recipient of the apparent unauthorized use of the non-domestic component, including a proposed corrective action, and should be given the opportunity to reply. If unauthorized use is confirmed, the State can take one or more of the following actions: request a waiver where appropriate; require the removal of the non-domestic item; or withhold payment for all or part of the project. Only EPA can issue waivers to authorize the use of a non-domestic item. EPA may use remedies available to it under the Clean Water Act, the Safe Drinking Water Act, and 40 CFR part 31 grant regulations, in the event of a violation of a grant term and condition.

It is recommended that the State work collaboratively with EPA to determine the appropriate corrective action, especially in cases where the State is the one who identifies the item in noncompliance or there is a disagreement with the assistance recipient.

If fraud, waste, abuse, or any violation of the law is suspected, the Office of Inspector General (OIG) should be contacted immediately. The OIG can be reached at 1-

888-546-8740 or OIG_Hotline@epa.gov. More information can be found at this website: <http://www.epa.gov/oig/hotline.htm>.

28) How do international trade agreements affect the implementation of the AIS requirements?

The AIS provision applies in a manner consistent with United States obligations under international agreements. Typically, these obligations only apply to direct procurement by the entities that are signatories to such agreements. In general, SRF assistance recipients are not signatories to such agreements, so these agreements have no impact on this AIS provision. In the few instances where such an agreement applies to a municipality, that municipality is under the obligation to determine its applicability and requirements and document the actions taken to comply for the State.

Waiver Process

The statute permits EPA to issue waivers for a case or category of cases where EPA finds (1) that applying these requirements would be inconsistent with the public interest; (2) iron and steel products are not produced in the US in sufficient and reasonably available quantities and of a satisfactory quality; or (3) inclusion of iron and steel products produced in the US will increase the cost of the overall project by more than 25 percent.

In order to implement the AIS requirements, EPA has developed an approach to allow for effective and efficient implementation of the waiver process to allow projects to proceed in a timely manner. The framework described below will allow States, on behalf of the assistance recipients, to apply for waivers of the AIS requirement directly to EPA Headquarters. Only waiver requests received from states will be considered. Pursuant to the Act, EPA has the responsibility to make findings as to the issuance of waivers to the AIS requirements.

Definitions

The following terms are critical to the interpretation and implementation of the AIS requirements and apply to the process described in this memorandum:

Reasonably Available Quantity: The quantity of iron or steel products is available or will be available at the time needed and place needed, and in the proper form or specification as specified in the project plans and design.

Satisfactory Quality: The quality of iron or steel products, as specified in the project plans and designs.

Assistance Recipient: A borrower or grantee that receives funding from a State CWSRF or DWSRF program.

Step-By-Step Waiver Process

Application by Assistance Recipient

Each local entity that receives SRF water infrastructure financial assistance is required by section 436 of the Act to use American made iron and steel products in the construction of its project. However, the recipient may request a waiver. Until a waiver is granted by EPA, the AIS requirement stands, except as noted above with respect to municipalities covered by international agreements.

The waiver process begins with the SRF assistance recipient. In order to fulfill the AIS requirement, the assistance recipient must in good faith design the project (where applicable) and solicit bids for construction with American made iron and steel products. It is essential that the assistance recipient include the AIS terms in any request for proposals or solicitations for bids, and in all contracts (see Appendix 3 for sample construction contract language). The assistance recipient may receive a waiver at any point before, during, or after the bid process, if one or more of three conditions is met:

1. Applying the American Iron and Steel requirements of the Act would be inconsistent with the public interest;
2. Iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Proper and sufficient documentation must be provided by the assistance recipient. A checklist detailing the types of information required for a waiver to be processed is attached as Appendix 1.

Additionally, it is strongly encouraged that assistance recipients hold pre-bid conferences with potential bidders. A pre-bid conference can help to identify iron and steel products needed to complete the project as described in the plans and specifications that may not be available from domestic sources. It may also identify the need to seek a waiver prior to bid, and can help inform the recipient on compliance options.

In order to apply for a project waiver, the assistance recipient should email the request in the form of a Word document (.doc) to the State SRF program. It is strongly recommended that the State designate a single person for all AIS communications. The State SRF designee will review the application for the waiver and determine whether the necessary information has been included. Once the waiver application is complete, the State designee will forward the application to either of two email addresses. For CWSRF waiver requests, please send the application to: cwsrfwaiver@epa.gov. For DWSRF waiver requests, please send the application to: dwsrfwaiver@epa.gov.

Evaluation by EPA

After receiving an application for waiver of the AIS requirements, EPA Headquarters will publish the request on its website for 15 days and receive informal comment. EPA Headquarters will then use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.

In the event that EPA finds that adequate documentation and justification has been submitted, the Administrator may grant a waiver to the assistance recipient. EPA will notify the State designee that a waiver request has been approved or denied as soon as such a decision has been made. Granting such a waiver is a three-step process:

1. Posting – After receiving an application for a waiver, EPA is required to publish the application and all material submitted with the application on EPA's website for 15 days. During that period, the public will have the opportunity to review the request and provide informal comment to EPA. The website can be found at: http://water.epa.gov/grants_funding/aisrequirement.cfm
2. Evaluation – After receiving an application for waiver of the AIS requirements, EPA Headquarters will use the checklist in Appendix 2 to determine whether the application properly and adequately documents and justifies the statutory basis cited for the waiver – that it is quantitatively and qualitatively sufficient – and to determine whether or not to grant the waiver.
3. Signature of waiver approval by the Administrator or another agency official with delegated authority – As soon as the waiver is signed and dated, EPA will notify the State SRF program, and post the signed waiver on our website. The assistance recipient should keep a copy of the signed waiver in its project files.

Public Interest Waivers

EPA has the authority to issue public interest waivers. Evaluation of a public interest waiver request may be more complicated than that of other waiver requests so they may take more time than other waiver requests for a decision to be made. An example of a public interest waiver that might be issued could be for a community that has standardized on a particular type or manufacturer of a valve because of its performance to meet their specifications. Switching to an alternative valve may require staff to be trained on the new equipment and additional spare parts would need to be purchased and stocked, existing valves may need to be unnecessarily replaced, and portions of the system may need to be redesigned. Therefore, requiring the community to install an alternative valve would be inconsistent with public interest.

EPA also has the authority to issue a public interest waiver that covers categories of products that might apply to all projects.

EPA reserves the right to issue national waivers that may apply to particular classes of assistance recipients, particular classes of projects, or particular categories of iron or steel products. EPA may develop national or (US geographic) regional categorical waivers through the identification of similar circumstances in the detailed justifications presented to EPA in a waiver request or requests. EPA may issue a national waiver based on policy decisions regarding the public's interest or a determination that a particular item is not produced domestically in reasonably available quantities or of a sufficient quality. In such cases, EPA may determine it is necessary to issue a national waiver.

If you have any questions concerning the contents of this memorandum, you may contact us, or have your staff contact Jordan Dorfman, Attorney-Advisor, State Revolving Fund Branch, Municipal Support Division, at dorfman.jordan@epa.gov or (202) 564-0614 or Kiri Anderer, Environmental Engineer, Infrastructure Branch, Drinking Water Protection Division, at anderer.kirsten@epa.gov or (202) 564-3134.

Attachments

Appendix 1: Information Checklist for Waiver Request

The purpose of this checklist is to help ensure that all appropriate and necessary information is submitted to EPA. EPA recommends that States review this checklist carefully and provide all appropriate information to EPA. This checklist is for informational purposes only and does not need to be included as part of a waiver application.

Items	☐	No
General • Waiver request includes the following information: — Description of the foreign and domestic construction materials — Unit of measure — Quantity — Price — Time of delivery or availability — Location of the construction project — Name and address of the proposed supplier — A detailed justification for the use of foreign construction materials • Waiver request was submitted according to the instructions in the memorandum • Assistance recipient made a good faith effort to solicit bids for domestic iron and steel products, as demonstrated by language in requests for proposals, contracts, and communications with the prime contractor		
Cost Waiver Requests • Waiver request includes the following information: — Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products — Relevant excerpts from the bid documents used by the contractors to complete the comparison — Supporting documentation indicating that the contractor made a reasonable survey of the market, such as a description of the process for identifying suppliers and a list of contacted suppliers		
Availability Waiver Requests • Waiver request includes the following supporting documentation necessary to demonstrate the availability, quantity, and/or quality of the materials for which the waiver is requested: — Supplier information or pricing information from a reasonable number of domestic suppliers indicating availability/delivery date for construction materials — Documentation of the assistance recipient's efforts to find available domestic sources, such as a description of the process for identifying suppliers and a list of contacted suppliers. — Project schedule — Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of construction materials • Waiver request includes a statement from the prime contractor and/or supplier confirming the non-availability of the domestic construction materials for which the waiver is sought • Has the State received other waiver requests for the materials described in this waiver request, for comparable projects?		

Appendix 2: HQ Review Checklist for Waiver Request

Instructions: To be completed by EPA. Review all waiver requests using the questions in the checklist, and mark the appropriate box as Yes, No or N/A. Marks that fall inside the shaded boxes may be grounds for denying the waiver. If none of your review markings fall into a shaded box, the waiver is eligible for approval if it indicates that one or more of the following conditions applies to the domestic product for which the waiver is sought:

1. The iron and/or steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality.
2. The inclusion of iron and/or steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

Review Items	Yes	No	N/A	Comments
Cost Waiver Requests				
• Does the waiver request include the following information?				
— Comparison of overall cost of project with domestic iron and steel products to overall cost of project with foreign iron and steel products				
— Relevant excerpts from the bid documents used by the contractors to complete the comparison				
— A sufficient number of bid documents or pricing information from domestic sources to constitute a reasonable survey of the market				
• Does the Total Domestic Project exceed the Total Foreign Project Cost by more than 25%?				
Availability Waiver Requests				
• Does the waiver request include supporting documentation sufficient to show the availability, quantity, and/or quality of the iron and/or steel product for which the waiver is requested?				
— Supplier information or other documentation indicating availability/delivery date for materials				
— Project schedule				
— Relevant excerpts from project plans, specifications, and permits indicating the required quantity and quality of materials				
• Does supporting documentation provide sufficient evidence that the contractors made a reasonable effort to locate domestic suppliers of materials, such as a description of the process for identifying suppliers and a list of contacted suppliers?				
• Based on the materials delivery/availability date indicated in the supporting documentation, will the materials be unavailable when they are needed according to the project schedule? (By item, list schedule date and domestic delivery quote date or other relevant information)				
• Is EPA aware of any other evidence indicating the non-availability of the materials for which the waiver is requested?				
Examples include:				
— Multiple waiver requests for the materials described in this waiver request, for comparable projects in the same State				
— Multiple waiver requests for the materials described in this waiver request, for comparable projects in other States				
— Correspondence with construction trade associations indicating the non-availability of the materials				
• Are the available domestic materials indicated in the bid documents of inadequate quality compared those required by the project plans, specifications, and/or permits?				

Appendix 3: Example Loan Agreement Language

ALL ASSISTANCE AGREEMENT MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE AIS REQUIREMENT. THIS IS AN EXAMPLE OF WHAT COULD BE INCLUDED IN SRF ASSISTANCE AGREEMENTS. EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THIS CLAUSE WITH RESPECT TO STATE LAW:

Comply with all federal requirements applicable to the Loan (including those imposed by the 2014 Appropriations Act and related SRF Policy Guidelines) which the Participant understands includes, among other, requirements that all of the iron and steel products used in the Project are to be produced in the United States (“American Iron and Steel Requirement”) unless (i) the Participant has requested and obtained a waiver from the Agency pertaining to the Project or (ii) the Finance Authority has otherwise advised the Participant in writing that the American Iron and Steel Requirement is not applicable to the Project.

Comply with all record keeping and reporting requirements under the Clean Water Act/Safe Drinking Water Act, including any reports required by a Federal agency or the Finance Authority such as performance indicators of program deliverables, information on costs and project progress. The Participant understands that (i) each contract and subcontract related to the Project is subject to audit by appropriate federal and state entities and (ii) failure to comply with the Clean Water Act/Safe Drinking Water Act and this Agreement may be a default hereunder that results in a repayment of the Loan in advance of the maturity of the Bonds and/or other remedial actions.

Appendix 4: Sample Construction Contract Language

ALL CONTRACTS MUST HAVE A CLAUSE REQUIRING COMPLIANCE WITH THE AIS REQUIREMENT. THIS IS AN EXAMPLE OF WHAT COULD BE INCLUDED IN ALL CONTRACTS IN PROJECTS THAT USE SRF FUNDS. EPA MAKES NO CLAIMS REGARDING THE LEGALITY OF THIS CLAUSE WITH RESPECT TO STATE OR LOCAL LAW:

The Contractor acknowledges to and for the benefit of the City of _____ (“Purchaser”) and the _____ (the “State”) that it understands the goods and services under this Agreement are being funded with monies made available by the Clean Water State Revolving Fund and/or Drinking Water State Revolving Fund that have statutory requirements commonly known as “American Iron and Steel;” that requires all of the iron and steel products used in the project to be produced in the United States (“American Iron and Steel Requirement”) including iron and steel products provided by the Contractor pursuant to this Agreement. The Contractor hereby represents and warrants to and for the benefit of the Purchaser and the State that (a) the Contractor has reviewed and understands the American Iron and Steel Requirement, (b) all of the iron and steel products used in the project will be and/or have been produced in the United States in a manner that complies with the American Iron and Steel Requirement, unless a waiver of the requirement is approved, and (c) the Contractor will provide any further verified information, certification or assurance of compliance with this paragraph, or information necessary to support a waiver of the American Iron and Steel Requirement, as may be requested by the Purchaser or the State. Notwithstanding any other provision of this Agreement, any failure to comply with this paragraph by the Contractor shall permit the Purchaser or State to recover as damages against the Contractor any loss, expense, or cost (including without limitation attorney’s fees) incurred by the Purchaser or State resulting from any such failure (including without limitation any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Purchaser). While the Contractor has no direct contractual privity with the State, as a lender to the Purchaser for the funding of its project, the Purchaser and the Contractor agree that the State is a third-party beneficiary and neither this paragraph (nor any other provision of this Agreement necessary to give this paragraph force or effect) shall be amended or waived without the prior written consent of the State.

Appendix 5: Sample Certifications

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

Date

Company Name

Company

Address City,

State Zip

Subject: American Iron and Steel Step Certification for Project (XXXXXXXXXX)

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

Item, Products and/or Materials:

1. Xxxx
2. Xxxx
3. Xxxx

Such process took place at the following location:

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

Signed by company representative

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

Date

Company Name

Company Address

City, State Zip

Subject: American Iron and Steel Certification for Project (XXXXXXXXXX)

I, (company representative), certify that the following products and/or materials shipped/provided to the subject project are in full compliance with the American Iron and Steel requirement as mandated in EPA's State Revolving Fund Programs.

Item, Products and/or Materials:

1. Xxxx
2. Xxxx
3. Xxxx

Such process took place at the following location:

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

Signed by company representative

AMERICAN IRON AND STEEL CERTIFICATION

1. Identification of American-made Iron and Steel: Consistent with the terms of the Borrower's bid solicitation and the provisions of the Consolidated Appropriations Act of 2014 ("Omnibus Spending Bill"), Section 436, the Bidder certifies that this bid reflects the Bidder's best, good faith to identify domestic sources of iron and steel for all iron and steel products contained in the bid solicitation where such American-made products are available on the schedule and consistent with the deadlines prescribed in or required by the bid solicitation.
2. Verification of U.S. Production: The Bidder certifies that all iron and steel products contained in the bid solicitation that are American-made have been so identified, and if this bid is accepted, the Bidder agrees that it will provide reasonable, sufficient, and timely verification to the Borrower of the U.S. production of each iron and steel product so identified through the completion of the step certification process.
3. The Bidder is responsible for submitting certified product information to the assistance recipient. Utilization of the step certification process is strongly encouraged. This process requires that each handler (supplier, fabricator, manufacturer, processor, etc.) of the iron and steel products certifies that their step in the process was domestically performed and provides a letter of certification from each supplier/fabricator on transfer of intermediate product. Step certification creates a paper trail which documents the location of the manufacturing process involved with the production of steel and iron materials. An example certification letter can be found in Appendix 5 of the American Iron and Steel Provisions in the SRF General Conditions.
4. The American Iron and Steel provision applies in a manner consistent with United States obligations under international agreements. Typically, these obligations only apply to direct procurement by the entities that are signatory to such agreements. State Revolving Fund assistance recipients are not signatories to such agreements, so these agreements have no impact on the American Iron and Steel provision. Claims from suppliers that the American Iron and Steel provision does not apply to certain products based on the International Trade Agreement exemptions of the Consolidated Appropriations Act of 2014 will not be accepted.
5. Documentation Regarding Non-American-made Iron or Steel: The Bidder certifies that for any iron and steel product that is not American-made and is so identified in this bid, the Bidders has included in or attached to this bid the following, as applicable:
 - a. Identification of and citation to a national waiver published by the U.S. Environmental Protection Agency on the official public Internet Web site of the Environmental Protection Agency that is applicable to such iron and steel product, and an analysis that supports its applicability to the iron and steel product;
 - b. Verifiable documentation sufficient to the Borrower that the waiver request process has been initiated. The assistance recipient may receive a waiver at any point before, during, or after the bid process, if one or more of three conditions is met:
 1. Applying the American Iron and Steel requirements of the Act would be inconsistent with the public interest;

2. Iron and steel products are not produced in the United States in sufficient and reasonably available quantities and of a satisfactory quality; or
3. Inclusion of iron and steel products produced in the United States will increase the cost of the overall project by more than 25 percent.

A checklist detailing the types of information required for a waiver to be processed can be found in Appendix 1 of the American Iron and Steel Provisions of the SRF General Conditions. Until a waiver is granted by EPA, the AIS requirements stand.

Bidder/Contractor

Date

Signature of Contractor/Title

**PROHIBITION ON CERTAIN TELECOMMUNICATIONS AND VIDEO SURVEILLANCE SERVICES
OR EQUIPMENT.**

2 CFR §200.216

(a) Recipients and subrecipients are prohibited from obligating or expending loan or grant funds to:

(1) Procure or obtain;

(2) Extend or renew a contract to procure or obtain; or

(3) Enter into a contract (or extend or renew a contract) to procure or obtain equipment, services, or systems that uses covered telecommunications equipment or services as a substantial or essential component of any system, or as critical technology as part of any system. As described in Public Law 115-232, section 889, covered telecommunications equipment is telecommunications equipment produced by Huawei Technologies Company or ZTE Corporation (or any subsidiary or affiliate of such entities).

(i) For the purpose of public safety, security of government facilities, physical security surveillance of critical infrastructure, and other national security purposes, video surveillance and telecommunications equipment produced by Hytera Communications Corporation, Hangzhou Hikvision Digital Technology Company, or Dahua Technology Company (or any subsidiary or affiliate of such entities).

(ii) Telecommunications or video surveillance services provided by such entities or using such equipment.

(iii) Telecommunications or video surveillance equipment or services produced or provided by an entity that the Secretary of Defense, in consultation with the Director of the National Intelligence or the Director of the Federal Bureau of Investigation, reasonably believes to be an entity owned or controlled by, or otherwise connected to, the government of a covered foreign country.

(b) In implementing the prohibition under Public Law 115-232, section 889, subsection (f), paragraph (1), heads of executive agencies administering loan, grant, or subsidy programs shall prioritize available funding and technical support to assist affected businesses, institutions and organizations as is reasonably necessary for those affected entities to transition from covered communications equipment and services, to procure replacement equipment and services, and to ensure that communications service to users and customers is sustained.

(c) See Public Law 115-232, section 889 for additional information.

(d) See also §200.471.

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION MANAGER AT RISK CONTRACT

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SUPPLEMENTARY CONDITIONS OF THE CONSTRUCTION MANAGER AT RISK CONTRACT

These Supplementary Conditions amend or supplement EJCDC® CMAR-700, Standard General Conditions of the Construction Manager at Risk Contract (2023). The General Conditions remain in full force and effect except as amended.

The terms used in these Supplementary Conditions have the meanings stated in the General Conditions. Additional terms used in these Supplementary Conditions have the meanings stated below, which are applicable to both the singular and plural thereof.

The address system used in these Supplementary Conditions is the same as the address system used in the General Conditions, with the prefix "SC" added: for example, "Paragraph SC-4.05" references modifications to General Conditions Paragraph 4.05.

ARTICLE 1—DEFINITIONS AND TERMINOLOGY

1.01 Defined Terms

SC-1.01.A.1 Add the following new paragraph immediately before Paragraph 1.01.A.1 and renumber the subsequent paragraphs:

1. **Abnormal Weather Conditions**—An event of weather that is substantially different from the climatic norms for Hill City, SD, as established by the National Oceanic and Atmospheric Administration (NOAA) or as determined by Owner's Advisor. Abnormal Weather Conditions include, but are not limited to, excessive precipitation, extreme cold or heat, flooding, or high winds, that could not reasonably have been anticipated and that materially and adversely affect the progress of the Work.

SC-1.01.A.53 Replace the definition with the following:

1. **Substantial Completion**—Is the stage in the progress of the Work when the Work is sufficiently complete in accordance with the Contract Documents so that the Owner may safely, reliably, and continuously utilize the Work for its intended wastewater treatment purposes without the need for continued Contractor presence or intervention, and when all conditions of this Section have been satisfied.
 - a. For wastewater treatment plant improvements, Substantial Completion shall not be achieved unless and until the following requirements have been fulfilled to the satisfaction of the Engineer and Owner:
 - 1) **System Installation and Functional Readiness**
All process equipment, mechanical systems, electrical systems, instrumentation and control systems, SCADA components, valves, piping, and appurtenances are fully installed, connected, and have passed functional and operational testing.
 - 2) **Commissioning Completion**
All commissioning activities required by the Contract Documents—including equipment startup, functional testing, control loop checks, alarm verification, system integration testing, and demonstration of automatic and manual modes—have been completed and documented.

- 3) Process Performance Capability
The Work has been demonstrated, through process performance testing or demonstration periods specified in the Contract Documents, to be capable of meeting applicable regulatory and performance requirements, including effluent quality and operational safety requirements.
 - 4) Operational Documentation
Interim Operation and Maintenance manuals, equipment data, manufacturer instructions, warranty information, operation procedures, and preliminary Record Documents (including as-built markups to date) have been submitted in a form acceptable to the Engineer.
 - 5) Training Completion
The Contractor has provided all required training for the Owner's operations and maintenance personnel for equipment, systems, and controls installed under the Work.
 - 6) Punch List Limited to Minor Items
Remaining items of work or deficiencies are minor, do not adversely affect operation, safety, or regulatory compliance, and can be completed without interference with the Owner's use of the Work.
 - 7) Safety and Access Requirements
All permanent access structures, safety systems, lighting, security devices, and other components required for safe Owner operation are fully installed and functional.
- b. Substantial Completion shall not be achieved if the Work requires temporary systems, manual workarounds, incomplete control system functionality, bypass pumping, temporary chemical feed systems, or any other temporary operational measures to maintain treatment performance or regulatory compliance.
 - c. When the Contractor believes Substantial Completion has been attained, the Contractor shall follow the procedures of Paragraph 15.03 of the General Conditions. The Engineer will conduct an inspection and, if appropriate, prepare and deliver to the Owner and Contractor the Certificate of Substantial Completion as provided in EJCDC C-700.

SC-1.01.A.4 Add the following sentence at the end of the last sentence of Paragraph 1.01.A.4:

4. Change Order form to be used on this Project is EJCDC C-941. Engineer and Owner approval are required before Change Orders are effective.

SC-1.01.A.25 Add the following new language at the end of Paragraph 1.01.A.25

25. Engineer's Consultant(s) on the Project include:

Chamberlin Architects, P.C

SC-1.01.A.45 Add the following new paragraph immediately after Paragraph 1.01.A.45 and renumber the subsequent paragraphs:

46. Project Manual—The written documents prepared for, or made available for, procuring and constructing the Work, including but not limited to the Bidding Documents or other construction procurement documents, geotechnical and existing conditions information, the Agreement, bond forms, general Conditions, Supplementary Conditions, and Specifications. The contents of the Project Manual may be bound in one or more volumes.
47. Resident Project Representative—The authorized representative of Engineer assigned to assist Engineer at the Site. As used herein, the term Resident Project Representative or “RPR” includes any assistants or field staff of Resident Project Representative. The entity/entities duly designated as Engineer’s Consultant(s) pursuant to SC-1.01.A.25 shall bear the RPR responsibilities as outlined in the Engineer and Subconsultant Agreement specific to the Project’s requirements.
48. Savings—Savings is the difference between (a) the GMP, as adjusted pursuant to the terms of this Agreement and less unused Owner’s Contingency and less unused Owner’s Allowances, and (b) the sum of the Cost of the Work, CMAR’s Construction Support Costs, CMAR’s Fee, and CMAR’s Contingency Use.

SC-1.01.A.62 Add the following language at the end of the last sentence of Paragraph 1.01.A.62:

Work Change Directives cannot change Guaranteed Maximum Price or Contract Times without a subsequent change order.

ARTICLE 2—PRELIMINARY MATTERS

2.01 Delivery of Bonds and Evidence of Insurance

SC-2.01 Delete Paragraphs 2.01.B. in its entirety and insert the following in their place:

- B. Evidence of CMAR’s Insurance—When CMAR delivers the signed counterparts of the Agreement to Owner, CMAR shall also deliver to Owner copies of the policies, including all endorsements, and identification of applicable self-insured retentions and deductibles, of insurance required to be provided by CMAR in this Contract (other than insurance such as builder’s risk that is required at a later date). CMAR may block out (redact) any confidential premium or pricing information contained in any policy or endorsement furnished under this provision.

2.02 Copies of Documents

SC-2.02.A Delete Paragraph 2.02.A in its entirety and insert the following new paragraph in its place:

- A. Neither Engineer nor Owner shall furnish printed copies of the Contract Documents (Project Manual, Drawings, etc.) to CMAR. CMAR shall be responsible for printing their own copies of the Contract Documents. Engineer and Owner shall provide copies in electronic portable document format (PDF) only. Printed copies of the conformed Contract Documents will be furnished upon request at the cost of production.

SC-2.03 Add the following paragraph immediately after Paragraph 2.02, and renumber the subsequent paragraphs:

2.03 Before Starting Construction

- A. Preliminary Schedules: Within 10 days after the Effective Date of the Contract (or as otherwise specifically required by the Contract Documents), CMAR shall submit to the Owner's Advisor for 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;
 2. a preliminary Schedule of submittals; and
 3. a preliminary Schedule of Values for all the Work, which includes quantities and prices of items that, 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 the performance of the Work. Such prices will include an appropriate amount of overhead and profit applicable to each item of Work.
- 2.04 Preconstruction Conference; Designation of Authorized Representatives
- A. Before any Work at the site is started, a conference attended by Owner, CMAR, Owner's Advisor, 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 2.03.A, procedures for handling Shop Drawings, Samples, and other submittals, processing Application for Payment, electronic or digital transmittals, and maintaining required records.
- B. At this conference, Owner and CMAR each shall designate, in writing, a specific individual to act as its authorized representative with respect to the services and responsibilities under the Contract. Such individual shall have the authority to transmit and receive information, render decisions relative to the Contract, and otherwise act on behalf of each respective party.
- 2.05 Initial Acceptance of Schedules
- C. At least 10 days before submission of the first Application for Payment, a conference, attended by CMAR, Owner's Advisor, and others as appropriate, will be held to review for acceptability to Owner's Advisor as provided below the schedules submitted in accordance with Paragraph 2.03A. CMAR shall have an additional 10 days to make corrections and adjustments and to complete and resubmit the schedules. No payment shall be made to CMAR until acceptable schedules are submitted to Owner's Advisor.
1. The Progress Schedule will be acceptable to Owner's Advisor if it provides an orderly progression of the Work to completion within the Contract Times. Such acceptance will not impose on Owner's Advisor responsibility for the Progress Schedule, for sequencing, scheduling, or progress of the Work, nor interfere with or relieve CMAR's full responsibility therefor.
 2. CMAR's Schedule of Submittals will be acceptable to Owner's Advisor if it provides a workable arrangement for reviewing and processing the required submittals.
 3. CMAR's Schedule of Values will be acceptable to Owner's Advisor as to form and substance if it provides a reasonable allocation of the Guaranteed Maximum Price to the parts of Work.

ARTICLE 3—CONTRACT DOCUMENTS—INTENT, REQUIREMENTS, REUSE

SC-3.01 Add the following new language immediately after Paragraph 3.01.G:

- H. Addenda and related modifications to the Drawings and/or Specifications take precedence over the original Construction Documents.

- I. The provisions of the Instructions to Bidders and Supplementary Conditions shall take precedence over the General Conditions. In the case of conflict, ambiguity, or discrepancy between Drawings and Specifications, or otherwise within the Contract Documents, the CMAR shall notify the OA for written resolution.
- J. Should there be a conflict within the Specifications, on the Drawings, or between the Specifications and the Drawings, in a written decision, the Owner's Advisor will decide and resolve the conflict that provides the best installations and operations outcomes, and Owner's Advisor's decision will be final.
- K. In the Drawings, the precedent shall be drawings of larger scale over those of smaller scale, figured dimensions over scaled dimensions, and noted materials over graphic indications.
- L. Dimensions on the Drawings are subject to field verification to suit adjacent elements and all elements of the Work and coordination with the Work of other contractors and subcontractors.

SC-3.03.A Add the following new language immediately after Paragraph 3.03.A.2:

- 3. CMAR shall not be liable to Owner or Owner's Advisor for failure to report any conflict, error, ambiguity, or discrepancy in the Contract Documents unless CMAR had actual knowledge thereof.

SC-3.04 Add the following new language immediately after the first sentence of Paragraph 3.04.A:

"Owner's Advisor will be the initial interpreter of the requirements of the Contract Documents, and judge of the acceptability of the Work thereunder."

SC-3.04 Add the following paragraph immediately after Paragraph 3.04.B:

- C. If a submitted matter in question concerns terms and conditions of the Contract Documents that do not involve (1) the performance or acceptability of the Work under the Contract Documents, (2) the design (as set forth in the Drawings, Specifications, or otherwise), or (3) other engineering or technical matters, the Owner's Advisor is unable to provide a decision or interpretation. If Owner and CMAR are unable to agree on the resolution of such a matter in question, either party may pursue resolution as provided in Article 12.

ARTICLE 4—COMMENCEMENT AND PROGRESS OF THE WORK

SC-4.03 Amend the first sentence of Paragraph 4.03.A to state the following:

"Owner shall provide engineering surveys to establish reference points for construction, which, in Owner's Advisor's judgement, are necessary to enable CMAR to proceed with Work"

SC-4.03 Add the following paragraph immediately after Paragraph 4.03.A:

- B. Reference points for the Work shall be provided by Engineer one (1) time, and subsequent re-establishment of reference points shall be the responsibility of the CMAR. CMAR shall notify the Engineer a minimum of seven (7) days in advance of the need for reference points for construction. All other layout and staking shall be the responsibility of the CMAR.

4.05 Delays in CMAR's Progress

SC-4.05 Amend Paragraph 4.05.C by replacing Paragraph 2 with the following:

- 2. Abnormal Weather Conditions

- a. If abnormal weather conditions are the basis for a request for an equitable adjustment in the Contract Times, such request must be documented by data substantiating each of the following: (1) that weather conditions were abnormal for the period of time in which the delay occurred, (2) that such weather conditions could not have been reasonably anticipated, and (3) that such weather conditions had an adverse effect on the Work as scheduled.
- b. The CMAR shall be responsible for monitoring and documenting the effects of abnormal weather conditions on the progress of the Work. If the CMAR believes that abnormal weather conditions have caused or will cause a delay to the critical path of the Project, the CMAR shall provide written notice to the Owner and Engineer within 30 days after the commencement of the delay. Such notice shall describe the specific weather events, the activities affected, and the anticipated impact on the Contract Times. The CMAR shall discuss and update the status of any weather-related delays at each regular construction progress meeting until the matter is resolved. Failure to provide timely written notice or to document such impacts may be grounds for denial of a request for adjustment of the Contract Times.

ARTICLE 5—SITE; SUBSURFACE AND PHYSICAL CONDITIONS; HAZARDOUS ENVIRONMENTAL CONDITIONS

SC-5.02 Add the following new language immediately after Paragraph 5.02.D:

E. Control of Work

1. CMAR shall perform the Work so that it will cause the least practicable interference with, and avoid prolonged interruption of or damage to, existing facilities, underground utilities, overhead utilities, and roadways. CMAR shall obtain written approval from the Owner at least twenty (20) days before performing any Work that involves either connection to existing facilities or interruption of service of existing operations. CMAR shall perform that Work when it causes the least interference or annoyance, as determined by the Owner and Owner's Advisor.
2. CMAR shall initiate, maintain, and supervise all weather protection and local and area climatic and seasonal precipitation event programs applicable to the Work. In the event of severe weather, CMAR shall immediately inspect the Work at the Site and take all necessary actions to ensure that public access and safety are maintained.
3. CMAR shall post construction signs to advise workers, occupants, pedestrians, and adjacent property owners of the limits of work areas, hardhat areas, excavation areas, construction parking, specific safety concerns, truck delivery access points and routes, etc.
4. Neither the Owner nor Owner's Advisor will accept or coordinate deliveries for CMAR. CMAR shall coordinate and be at the site to receive all deliveries. Materials and equipment stored on the site or right of way shall be placed so as to ensure minimum danger and obstruction to the traveling public.
5. CMAR shall take whatever steps, procedures, or means required to prevent dust nuisance due to the CMAR's operations on-site, along haul routes, within stockpile areas, and within or along equipment or material staging areas. Dust control measures shall be maintained at all times to the satisfaction of the Owner and Owner's Advisor and as required by any other Political Subdivision with jurisdiction.

6. CMAR shall take whatever steps, procedures, or means required to minimize noise nuisance due to CMAR's operations on-site, along haul routes, within stockpile areas, and with in or along equipment or material staging areas.
7. Any dumping of spoil or waste material by CMAR shall comply with all federal, state, and local laws and regulations. Whether public or private landfills are used, CMAR shall pay all required dumping fees and shall furnish to the Owner's Advisor evidence of such payments.

SC-5.03 Delete Paragraphs 5.03.E, 5.03.F., and 5.03.G and replace with the following new Paragraphs after 5.03.D:

- E. During the preconstruction phase, the CMAR may propose and perform additional exploratory investigations, such as test borings, utility investigations, or other field verification activities, when such investigations are reasonably necessary to support design development or clarification of existing conditions. Any such investigations shall be coordinated with the Owner in advance and funded in accordance with Exhibit A and the preconstruction allowances established for exploratory work.

After establishment of the Guaranteed Maximum Price (GMP) and commencement of construction, it shall be the responsibility of the CMAR to determine to CMAR's own satisfaction the location and nature of surface and subsurface obstacles and the soil and water conditions that will be encountered during the Work. Reports and existing drawings provided by the Owner are for reference only.

- F. The following reports of exploration and tests of subsurface conditions at or adjacent to the Site are known to Owner

1. Geotechnical Report by American Engineering Testing (AET), Dated August 14, 2025 and included with the Proposal Documents.

- G. In the preparation of Drawings and Specifications, Engineer and Engineer's Consultants relied upon the following drawings of physical conditions in or relating to existing surface and subsurface structures (except Underground Facilities) which are at or contiguous to the Site:

1. City of Hill City Advanced Wastewater Treatment Plant, Dated February, 2006

SC-5.04 Add the following sentence as the final sentence to Paragraph 5.04.A:

Satisfaction of CMAR's duty to give written notice to the Owner and Owner's Advisor of such a differing site condition before performing work in connection therewith is a condition precedent to CMAR's entitlement to an adjustment of price or time pursuant to the General Conditions.

SC-5.05 Add the following new paragraphs immediately after paragraph 5.05.F:

- G. The following reports of exploration and test related to Underground Facilities at the Site are known to Owner:

1. Geotechnical Report by American Engineering Testing (AET), Dated August 14, 2025 and included with the Proposal Documents.

- H. CMAR shall be responsible for immediately notifying the Owner's Advisor of any contact with or damage to Underground Utilities included under 5.05.A and 5.05.B, and for the safety, protection, and repairing of any damages done to the Work and surface and subsurface facilities and Underground Utilities.

- I. CMAR shall be responsible for coordinating, obtaining, and paying for the services of specialized existing utility observation/inspection services personnel during the performance of work near existing utilities per existing utility owner requirements.
- J. Prior to any excavation CMAR shall call for and obtain a utility locate. Underground Utility locations can be obtained from the following Location Services in South Dakota:

South Dakota One Call: 811

SC-5.06 Delete Paragraphs 5.06.A and 5.06.B in their entirety and insert the following:

- A. No reports or drawings related to Hazardous Environmental Conditions at the Site are known to Owner, other than what has been disclosed in the Proposal Documents.
- B. [Intentionally omitted].

SC-5.06 Add the following paragraph immediately after Paragraph 5.06.K:

- L. Asbestos containing materials are prohibited from use in the construction of this Project. CMAR shall certify that only non-asbestos materials were used. Typical materials likely to contain asbestos include roofing, acoustical treatments, fireproofing, drywall, plaster, resilient flooring, insulations, mastics/adhesives, gaskets, mineral products, cementitious boards/pipes/mortar, etc.

ARTICLE 6—BONDS AND INSURANCE

SC-6.01 Add the following subparagraphs immediately after Paragraph 6.01.C:

1. Required Performance Bond Form—The performance bond that CMAR furnishes will be in the form of EJCDC® C-610, Performance Bond (2018).
2. Required Payment Bond Form—The payment bond that CMAR furnishes will be in the form of EJCDC® C-615, Payment Bond (2018).

SC-6.02 Amend the first sentence of Paragraph 6.02.N. to read as follows:

Replace the word “10” with “Thirty days (30)”. And so amended Paragraph GC-6.02.N remains in effect.

SC-6.03 Add the following new paragraph immediately after Paragraph 6.03.C:

- D. The limits of liability for insurance required by Paragraph 6.03 of the General Conditions shall provide the following coverage for not less than the following amounts or greater where required by Laws and Regulations.

Worker’s Compensation, and related coverages:	
State	Statutory
Applicable Federal	Statutory
Employer’s Liability:	
Bodily injury, each accident	\$2,000,000
Bodily injury by disease, each employee	\$2,000,000
Bodily injury/disease aggregate	\$2,000,000
Foreign voluntary worker compensation:	
	Statutory
Contractor’s General Liability:	
General Aggregate	\$2,000,000
Products – Completed Operations Aggregate	\$2,000,000

Personal and Advertising Injury	\$2,000,000
Each Occurrence (Bodily Injury and Property Damage)	\$2,000,000
Automobile Liability:	
Bodily Injury	
Each Person	\$2,000,000
Each Accident	\$2,000,000
Property Damage – Each Accident	\$2,000,000
Combined Single Limit	\$2,000,000
Excess or Umbrella Liability:	
General Aggregate	\$5,000,000
Each Occurrence	\$5,000,000
The Excess or Umbrella Liability coverage shall stack on top of the liability coverages to the fullest extent permitted under the policy but at minimum over the required Contractor's General Liability and Automobile Liability coverage	
Contractor's Professional Liability:	
Each Occurrence	\$2,000,000
General Aggregate	\$2,000,000
Mobile Equipment:	\$2,000,000
Additional Insured – Required Additional Insureds for all of the above identified policies:	
City of Hill City, SD	
Advanced Engineering and Environmental Services, LLC	
Chamberlin Architects, P.C.	

- E. CMAR and Owner each waives any and all subrogation rights to recover against the other or against any of the party's agents, including but not limited to the Engineer and Engineer's Consultants, arising from any cause covered by any insurance required to be carried by such party pursuant to this Contract or any other insurance actually carried by such party to the extent of the limits of such policy, subject to the limitation that this waiver shall apply only when permitted by the applicable policy or policies of insurance without additional premium therefore and thereafter only if a party shall pay such part of any additional premium of the other party attributable thereto.
- F. Each certificate of insurance shall provide that the insurer must give at least 30 days prior to written notice of cancellation and/or termination of the coverage thereunder.

SC-6.05 Delete Paragraph 6.05.A in its entirety and insert the following in its place and renumber subsequent paragraphs:

- A. CMAR shall purchase and maintain the following insurance upon the Work at the Site in the amount of the full replacement cost thereof.
1. This insurance shall:
 - a. Include the interests of Owner, CMAR, Subcontractors, Owner's Advisor, Engineer, and any other individuals or entities herein, and the officers, directors, partners, employees, agents and other consultants and subcontractors of any of them each of whom is deemed to have an insurable interest and shall be listed as an insured or additional insured;
 - b. 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 and 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, lighting, extended coverage, theft, vandalism and malicious mischief, earthquake, collapse, debris removal, demolition occasioned by enforcement of Laws and Regulations, water damage (other than that caused by flood), and such other perils or causes of loss as may be specifically required by the Supplementary Conditions;

- c. Contain provisions to the effect that in the event of payment of any loss or damage the insurer will have no rights to recovery against any insureds thereunder, or against Engineer or its consultants, or their officers, directors, members, partners, employees, agents, consultants, or subcontractors;
 - d. Include expenses incurred in the repair or replacement of any insured property (including but not limited to fees and charges of engineers and architects);
 - e. 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;
 - f. Allow for partial utilization of the Work by Owner;
 - g. Include testing and startup; and
 - h. Be maintained in effect until final payment is made unless otherwise agreed to in writing by Owner, CMAR and Owner's Advisor with thirty (30) days written notice to each other additional insured to whom a certificate of insurance has been issued.
2. Contractor shall be responsible for any deductible or self-insured retention.
3. The policies or insurance required to be purchased and maintained by CMAR in accordance with this Paragraph SC-6.05.A. shall not conflict with the requirements of Paragraph 6.05.B, 6.05.C, and 6.05.D of the General Conditions.

ARTICLE 7—CMAR'S RESPONSIBILITIES

SC-7.02.A Add the following subparagraph to Paragraph 7.02.A:

- 1. The CMAR shall provide a superintendent in charge of the overall project. The Superintendent shall be a competent individual who is fully authorized and capable of managing, directing, and coordinating the project; who is fully experienced in the type of work being performed; who is capable of reading and thoroughly understanding the plans and specifications and who is authorized to receive instructions from the Engineer and his representatives. A CMAR superintendent must be on site whenever Work is being performed. Superintendent must have worked as a superintendent on previous projects.

SC-7.02 Add the following new paragraph immediately after Paragraph 7.02.B:

- C. CMAR shall schedule and conduct meetings to discuss such matters as procedures, progress, coordination, scheduling, and status of the Work. CMAR shall prepare and promptly distribute minutes to Owner, Owner's Advisor, and Engineer.

- SC-7.06 Amend the first sentence of Paragraph 7.06.D to state the following:
- “..., all Work at the Site shall be performed during regular working hours, Monday through Friday, 7:00 AM through 7:00 PM CST. Work on Saturday, Sunday, or legal holidays shall only be allowed 8:00 AM through 6:00 PM CST when pre-authorized by Owner. CMAR shall notify Owner’s Advisor of any work planned on Saturday, Sunday, or any legal holidays, or outside of the regular working hours at least 48 hours prior to such work.”
- SC-7.10 Add the following new paragraph immediately after Paragraph 7.10.C and renumber subsequent paragraphs:
- D. This project is being funded in part by the Clean Water State Revolving Loan Fund (CWSRF). The CMAR shall comply with all requirements as set forth in the Civil Rights Provisions, Special Equal Opportunity Provisions, and Federal Labor Standards Provisions, as set forth by the CWSRF program.
- SC-7.10 Add the following new subparagraph immediately after Paragraph 7.10.E:
1. An experience statement shall accompany such lists with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor and Supplier.
- SC-7.12 Add the following paragraph immediately after 7.12.A:
- B. CMAR shall obtain such permits, certificates, and licenses that are required for completion of the Work. Permits, certificates, and licenses included, but are not limited to:
1. National Pollution Discharge Elimination System (NPDES) Storm Water Permit.
 2. South Dakota Department of Agriculture & Natural Resources (SD DANR) Dewatering Permit.
 3. City of Hill City building permits including but not limited to: Commercial/Industrial Building Permit, Electrical permits, and Fire protection permit.
 4. Demolition Permit from the State of South Dakota and/or City of Hill City.
 5. Certificate of Occupancy from the City of Hill City.
 6. Permits required for disposal of construction debris removed from Project Site(s) or generated during the execution of the Work.
 7. Additional permits or approvals that may be required by the City of Hill City, the State of South Dakota, and/or other local and State agencies.
- C. CMAR shall coordinate all permit requirements and schedule all required inspections through Construction.
- D. Mechanical and Plumbing Subcontractor(s) must be licensed in the City of Hill City. License fee is not refundable by the City.
- E. CMAR is responsible for all permit, certificate, and license fees.

ARTICLE 8—OTHER WORK AT THE SITE

- SC-8.04 Add the following new language immediately after Paragraph 8.03:
- 8.04 Claims Between Contractors
- A. Should CMAR, Subcontractors, or Suppliers cause damage to the Work or property of any person without limitation, at the Site, or should any claim arising out of CMAR’s, Subcontractors’, or

Suppliers' performance of the Work at the Site be made by any person against CMAR, Owner, Owner's Advisor, Engineer, Engineer's Consultants, or the Construction Coordinator, CMAR shall promptly attempt to settle with such other contractor by agreement, or to otherwise resolve the dispute by arbitration or at law.

- B. CMAR shall, to the fullest extent permitted by Laws and Regulations, indemnify, defend, and hold harmless Owner, Owner's Advisor, Engineer, Engineer's Consultants, Construction Coordinator and the officers, directors, partners, employees, agents, and other consultants and subcontractors of each and any of them from all claims, costs, losses and damages (including, but not limited to, fees and charges of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly, or consequently out of any action, legal or equitable, brought by any separate contractor against Owner, Owner's Advisor, Engineer, Engineer's Consultants, or the Construction Coordinator to the extent said claim is based on or arises out of CMAR's performance of the Work, except to the extent said claim is caused by the negligence or direction of Owner, Owner's Advisor, Engineer, Engineer's Consultants, Construction Coordinator and the officers, directors, partners, employees, agents, and other consultants and subcontractors.
- C. Owner shall, to the fullest extent permitted by Laws and Regulations, indemnify, defend, and hold harmless Contractor should a separate contractor cause damage to the Work or property of CMAR or should the performance of the Work by any separate contractor at the Site give rise to any other Claim.
- D. If CMAR is delayed at any time in performing or furnishing Work by any act or neglect of a separate contractor and Owner and CMAR are unable to agree as to the extent of any adjustment in Contract Times attributable thereto, CMAR may make a Claim for an extension of times in accordance with Article 12. An extension of the Contract Times shall be CMAR's exclusive remedy with respect to Owner, Owner's Advisor, Engineer, Engineer's Consultants, and Construction Coordinator for any delay, disruption, interference or hindrance caused by any separate contractor. This paragraph does not prevent recovery from Owner, Owner's Advisor, Engineer, Engineer's Consultant, or Construction Coordinator for activities that are their respective responsibilities.

ARTICLE 9—OWNER'S RESPONSIBILITIES

No suggested Supplementary Conditions in this Article.

ARTICLE 10—STATUS OF OWNER'S ADVISOR AND ENGINEER DURING CONSTRUCTION

SC-10.05 Add the following new paragraph immediately after Paragraph 10.05.D:

- E. The limitations upon authority and responsibility set forth in this Paragraph 10.05 shall also apply to the Resident Project Representative, if any.

SC-10.07 Add the following new paragraphs immediately after Paragraph 10.06:

10.07 Resident Project Representative

- A. If Owner and Engineer have agreed that Engineer furnish a Resident Project Representative to represent Engineer at the Site and assist Engineer in observing the progress and quality of the Work, then the authority and responsibilities of any such Resident Project Representative will be as provided in the Supplementary Conditions, and limitations on the responsibilities thereof will be as provided in the Supplementary Conditions and in Paragraph 10.07.

- B. If Owner designates an individual or entity who is not Engineer's consultant, agent, or employee to represent Owner at the Site, then the responsibilities and authority of such individual or entity will be as provided in the Supplementary Conditions.
- C. The Resident Project Representative (RPR) will be Engineer's representative at the Site, will act as directed by and under the supervision of the Engineer, and will confer with Engineer regarding RPR's actions.
 - 1. General: RPR's dealings in matters pertaining to the Work in general shall be with Engineer and CMAR. RPR's dealings with Subcontractors shall only be through or with full knowledge and approval of CMAR.
 - 2. Schedules: Review the progress schedule, schedule of Shop Drawing and Sample submittals, and Schedule of Values prepared by CMAR and consult with Engineer concerning acceptability.
 - 3. Conferences and Meetings: Attend meetings with CMAR, such as preconstruction conferences, progress meetings, job conferences, and other Project-related meetings, and prepare and circulate copies of minutes thereof unless stipulated to be CMAR's responsibility elsewhere in the Construction Documents.
 - 4. Liaison:
 - a. Serve as Engineer's liaison with CMAR. Working principally through CMAR's authorized representative or designee, assist in providing information regarding the provisions and intent of the Contract Documents.
 - b. Assist Engineer in serving as Owner's liaison with CMAR when CMAR's operations affect Owner's on-Site operations.
 - c. Assist in obtaining from Owner additional details or information, when required for proper execution of the Work.
 - 5. Interpretation of Contract Documents: Report to Engineer when clarifications and interpretations of the Contract Documents are needed and transmit to CMAR clarifications and interpretations as issued by Engineer.
 - 6. Shop Drawings and Samples:
 - a. Record date and receipt of Samples and CMAR-approved Shop Drawings
 - b. Receive Samples which are furnished at the Site by CMAR and notify Engineer of availability of Samples for examination.
 - c. Advise Engineer and CMAR of the commencement of any portion of the Work requiring a Shop Drawing or Sample submittal for which RPR believes that the submittal has not been approved by Engineer.
 - 7. Modifications: Consider and evaluate CMAR's suggestions for modifications in Drawings or Specifications and report such suggestions, together with RPR's recommendations, if any, to Engineer. Transmit to CMAR in writing decisions as issued by Engineer.
 - 8. Review of Work and Rejection of Defective Work:
 - a. Conduct on-Site observations of CMAR's work in progress to assist Engineer in determining if the Work is in general proceeding in accordance with the Contract Documents.

- b. Report to Engineer whenever RPR believes that any part of CMAR's work in progress is defective, will not produce a complete Project that conforms generally to the Contract Documents, or will imperil the integrity of the design concept of the completed Project as functioning whole as indicated in the Contract Documents, or has been damaged, or does not meet the requirements of any inspection, test or approval required to be made; and advise Engineer of that part of the work in progress that RPR believes should be corrected or rejected or should be uncovered for observation, or requires special testing, inspection, or approval.
9. Inspections, Tests, and System Start-ups:
- a. Verify that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate Owner's and Engineer's personnel, and that Contractor maintains adequate records thereof.
 - b. Observe, record, and report to Engineer appropriate details relative to the test procedures and systems start-ups.
10. Records:
- a. Prepare a daily report or keep a diary or log book, recording CMAR's hours on the Site, Subcontractors present at the Site, weather conditions, data relative to questions of Change Orders, Field Orders, Work Change Directives, or changed conditions, Site visitors, deliveries of equipment or materials, daily activities, decisions, observations in general, and specific observations in more detail as in the case of observing test procedures; and send copies to Engineer.
 - b. Record names, addresses, fax numbers, e-mail addresses, web site locations, and telephone numbers of CMAR and all Subcontractors and major Suppliers of materials and equipment.
 - c. maintain records for use in preparing Project documentation.
11. Reports:
- a. Furnish to Engineer periodic reports as required of progress of the Work and of CMAR's compliance with the Progress Schedule and schedule of Shop Drawing and Sample submittals.
 - b. Draft and recommend to Engineer proposed Change Orders, Work Change Directives, and Field Orders. Obtain backup material from Contractor.
 - c. Immediately notify Engineer of the occurrence of any Site accidents, emergencies, acts of God endangering the Work, force majeure or delay events, damage to property by fire or other causes, or the discovery of any Constituent of Concern or Hazardous Environmental Condition.
12. Payment Requests: Review applications for payment with Contractor for compliance with the establishment procedure for their submission and forward with recommendations to Engineer, noting particularly the relationship of the payment requested to the Schedule of Values, Work completed, and materials and equipment delivered at the Site but not incorporated in the Work.
13. Certificates, Operations and Maintenance Manuals: During the course of the Work, verify that materials and equipment certificates, operation and maintenance manuals, and other data required by the Contract Documents to be assembled and furnished by CMAR are applicable to

the items actually installed and in accordance with the Contract Documents, and have these documents delivered to Engineer for review and forwarding to Owner prior to payment for that part of the Work.

14. Completion:

- a. Participate in Engineer's visits to the Site to determine Substantial Completion, assist in the determination of Substantial Completion and the preparation of a punch list of items to be completed or corrected.
 - b. Participate in Engineer's final visit to the Site to determine completion of the Work, in the company of Owner and CMAR, and prepare a final punch list of times to be completed and deficiencies to be remedied.
 - c. Observe whether all items on the final list have been completed or corrected and make recommendations to Engineer concerning acceptance and issuance of the notice of acceptability of the Work.
- D. RPR's authority and duties and responsibilities are limited exclusively to those identified above. For avoidance of doubt, but not as complete list, but rather to underscore the RPR's limited duties and responsibilities, the RPR shall not:
1. Authorize any deviation from the Contract Documents or substitution of materials or equipment (including "or-equal" items).
 2. Exceed limitations of Engineer's authority as set forth in the Contract Documents.
 3. Undertake any of the responsibilities of CMAR, Subcontractors, or Suppliers.
 4. Advise on, issue directions relative to, or assume control over any aspect of the means, methods, techniques, sequences or procedures of CMAR's work.
 5. Advise on, issue directions regarding, or assume control over security or safety practices, precautions, and programs in connection with the activities or operations of Owner or CMAR.
 6. Participate in specialized field or laboratory tests or inspections conducted off-site by others except as specifically authorized by Engineer.
 7. Accept Shop Drawing or Sample submittals from anyone other than CMAR.
 8. Authorize Owner to occupy the Project in whole or in part.

10.08 Rejecting Defective Work

- A. Owner's Advisor and Engineer has the authority to reject Work in accordance with Article 14.

10.09 Shop Drawings

- A. Engineer's authority, and limitations thereof, as to Shop Drawings and Samples, are set forth in Paragraph 7.19.
- B. 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, are set forth in Paragraph 7.22.
- C. Engineer's authority as to Change Orders is set forth in Article 11.
- D. Engineer's authority as to Applications for Payment is set forth in Article 15.

ARTICLE 11—CHANGES TO THE CONTRACT

SC-11.03 Add the following paragraph immediately after Paragraph 11.03.A:

- B. Except as specifically authorized in writing by the Engineer at the time additional work is done beyond the original scope of the Contract Documents, the CMAR shall make no claims for additional compensation. The CMAR's plea of ignorance of foreseeable conditions which will create difficulties or hindrances in the execution of the work will not be acceptable to the Owner as an excuse for failure of the Contractor to fulfill the requirements of the Contract Documents and shall not be a basis for the CMAR's claim for additional compensation. Discrepancies in, or conflicts between, the items described in these Contract Documents must be submitted in writing to the Engineer for adjustment prior to proceeding with the work, as any claims for additional compensation to achieve compliance with the requirements for those items will not be allowed or considered.

SC-11.03 Add the following paragraph 11.07.C after 11.07.B

- C. "Construction Manager's Fee: The Construction Manager's Fee for overhead and profit shall be a mutually acceptable fixed Rate."

ARTICLE 12—CLAIMS

SC-12.01.A Add the following paragraph immediately after Paragraph 12.01.A.3:

- 1. Disputes that Engineer has been unable to address because they do not involve the design (as set forth in the Drawings, Specifications, or otherwise), the acceptability of the Work, or other engineering or technical matters.

SC-12.01.B Amend the first sentence of Paragraph 12.01.B to read as follows:

Replace the words "~~in no event later than 30 days~~" with "in no event later than 21 days". So amended, Paragraph 12.01.B remains in full effect.

ARTICLE 13—ALLOWANCES; UNIT PRICE WORK

SC-13.01.E Add the following new paragraph immediately after Paragraph 13.01.E:

- F. Contingency Allowance (Owner): Construction Manager agrees that Owner's Contingency Allowance, if any, is for the sole use of Owner to cover Owner's unanticipated costs.

SC-13.03 Add the following new paragraph immediately after Paragraph 13.02:

13.03 Related Party Transactions

- A. For Purposes of Paragraph 13.03, the term "related party" shall mean a parent, subsidiary, affiliate or other entity having common ownership or management with the CMAR; any entity in which any stockholder in, or management employee of, the CMAR owns any interest in excess of ten percent in the aggregate; or any person or entity which has the right to control the business or affairs of the CMAR. The term "related party" includes any member of the immediate family of any person identified above.

- B. If any of the costs to be reimbursed arise from a transaction between the CMAR and a related party, the CMAR shall notify the Owner of the specific nature of the contemplated transaction, including the identity of the related party and the anticipated cost to be incurred, before any such transaction is consummated or cost incurred. If the Owner, after such notification, authorizes the proposed transaction, then the cost incurred shall be included as a cost to be reimbursed, and the CMAR shall procure the Work, equipment, goods or service from the related party, as a Subcontractor, according to the terms of Section 7.06. If the Owner fails to authorize the transaction, the CMAR shall procure the Work, equipment, goods or service from some person or entity other than a related party according to the terms of Section 7.06.

ARTICLE 14—TESTS AND INSPECTIONS; CORRECTION, REMOVAL, OR ACCEPTANCE OF DEFECTIVE WORK

SC-14.02.D Add the following to the end of paragraph 14.02.D:

All inspections and testing laboratories must have prior approval of the Owner's Advisor or Engineer.

ARTICLE 15—PAYMENTS TO CMAR; SET OFFS; COMPLETION; CORRECTION PERIOD

SC-15.02.A.2 Amended the first sentence of Paragraph 15.02.A.2 to read as follows:

Replace the words "Owner's Advisor" with the "CMAR".

SC-15.02.B.1 Amend the first sentence of Paragraph 15.02.B.1 to read as follows:

Replace the words "At least 20 days" with "At least 10 days". And as amended paragraph 15.01.D.1 remains in effect

SC-15.02.C.5 Amend Paragraph 15.02.C.5 to read as follows:

5. Owner's Advisor may refuse to recommend the whole payment or any part of the payment (i) if in the Owner's Advisor's opinion the established Contract Time for Substantial Completion has expired; or (ii) if in the Owner's Advisor's opinion it would be incorrect to make the representations to Owner stated in 15.01.C.2.

Such refusal to recommend payment shall not constitute a waiver of the CMAR's right to payment for Work properly performed, but payment may be delayed until the Contract Time or progress status is resolved and accurate certification can be provided.

SC-15.02.C.6 Add the following new language at the end of the Paragraph 15.02.C.6.e:

- f. Failure to make payment to Subcontractors, System Suppliers, or labor.
- g. Claims made by Owner's Advisor for additional compensation because of CMAR delays or rejection of defective Construction Work.
- h. Deduction per the Agreement.
- i. Liability for liquidated damages has been incurred by CMAR.

SC-15.02.D.1 Amend the first sentence of Paragraph 15.02.D.1 to read as follows:

Replace the words “Ten days” with “Twenty (20) days after transmittal of loan funds from the Funding Agency to the Owner”. And as amended paragraph 15.01.D.1 remains in effect

SC-15.04 Add the following to the end of Paragraph 15.04.B:

“If some or all of the Work has been determined not to be at a point of Substantial Completion and will require re-inspection or re-testing by OA and Engineer, the documented cost of such re-inspection or re-testing shall be paid by the CMAR to the Owner.

Such costs shall be limited to the Owner’s Advisor’s standard hourly billing rates and actual reimbursable expenses, without administrative markup, and shall be reasonable in relation to the scope of the re-inspection required.

CMAR shall not be charged for re-inspection or re-testing costs arising from causes beyond the CMAR’s control or from Owner-directed changes.

If CMAR does not pay, or if the parties cannot agree on the amount owed, the Owner may impose a reasonable set-off against payments due under this Article 15.”

SC-15.06.A Add the following language at the end of the second sentence of Paragraph 15.06.A:

“If, after such measures are taken, subsequent inspections by Owner’s Advisor reveal that any of the previously identified items remain incomplete or defective, Owner’s Advisor will notify CMAR in writing of the remaining items. All costs associated with any subsequent inspections will be documented by Owner’s Advisor, Owner will compensate Owner’s Advisor, and CMAR shall reimburse Owner. Owner will deduct amount of compensation paid to Owner’s Advisor from the payment to the CMAR. Compensation shall be at the Owner’s Advisor’s standard hourly rates plus actual cost of reimbursables.”

SC-15.06.B Add the following new paragraph immediately after paragraph 15.06.A, which is to read as follows:

- B. Upon correction of deficiencies and completion of the entire work, CMAR shall notify Owner’s Advisor in writing requesting a final inspection. If, in the Opinion of the Owner’s Advisor, the CMAR has satisfactorily completed the Work, CMAR, Owner’s Advisor, and Owner shall execute the Final Inspection and Acceptance.

SC-15.07.A.2 Add the following paragraph immediately after 15.07.A.2.e:

- f. Certificate of Occupancy issued by the City of Hill City.

SC-15.07.C Add the following paragraphs immediately after 15.07.E:

- F. Owner’s Right to Audit CMAR’s Final Accounting
 - 1. The Owner retains the right to audit CMAR’s final accounting within 30 days after delivery of the final accounting to Owner’s Advisor by the CMAR. Upon completion of Owner’s audit of CMAR’s final accounting, Owner shall provide a copy of the audit report to CMAR.
 - 2. If Owner’s auditors report of the Cost of the Work as substantiated by the CMAR’s final accounting to be less than claimed by CMAR, CMAR shall be entitled to mediation of the disputed amount. A request for mediation shall be made by CMAR within 30 days after CMAR’s receipt of a copy of the audit report. Failure to request mediation within this 30-day period shall result in the substantiated amount reported by Owner’s auditors becoming binding on CMAR and immediately payable by CMAR to Owner.

SC-15.09.B Amend the first sentence of Paragraph 15.09.B by striking out the following words and adding the following:

- B. Delete words “Substantial Completion” and replace with words “Final Acceptance by Owner”

ARTICLE 16—SUSPENSION AND TERMINATION

SC-16.03 Delete Paragraph 16.03.A.3. in its entirety and insert an “and” after the end of the sentence 16.03.A.1 and replace the semi-colon with a period at the end of the sentence 16.03.A.2.

ARTICLE 17—FINAL RESOLUTION OF DISPUTES

SC-17.01.C Add the following paragraph immediately after Paragraph 17.01.B.3:

- 4. Any claim, dispute, or other matter in question arising out of or related to this Agreement shall be subject to mediation. Mediation is not a condition precedent to commencing litigation, but if litigation is commenced, the parties agree to mediate before any dispositive motions or trial. Litigation may only be commenced in state or federal court having jurisdiction in the place where the Work is located, within the time periods prescribed by applicable law.

ARTICLE 18—MISCELLANEOUS

No suggested Supplementary Conditions in this Article.

CERTIFICATION OF PROHIBITED ENTITY STATUS
SDCL 5-18A-51

As a required portion of the bid being submitted to Hill City, SD, Bidder submits this certification.

SDCL 5-18A-1(19A) defines "Prohibited Entity" as follows:

"[A]n organization, association, corporation, partnership, joint venture, limited partnership, limited liability partnership, limited liability company, or other entity or business association, including all wholly owned subsidiaries, majority-owned subsidiaries, parent companies, or affiliates, of those entities or business associations, regardless of their principal place of business, which is ultimately owned or controlled by:

- (a) A foreign parent entity from the People's Republic of China, the Republic of Cuba, the Islamic Republic of Iran, the Democratic People's Republic of Korea, the Russian Federation, or the Bolivarian Republic of Venezuela; or
- (b) The government of the People's Republic of China, the Republic of Cuba, the Islamic Republic of Iran, the Democratic People's Republic of Korea, the Russian Federation, or the Bolivarian Republic of Venezuela.

A prohibited entity does not include a citizen or legal permanent resident of the United States, or an individual foreign national.

The undersigned hereby certifies to the District the following:

1. I am an authorized representative and agent of _____
_____ (Bidder);
2. Check one:
 ___ Bidder is not a Prohibited Entity as defined by SDCL 5-18A-1(19A); or
 ___ Bidder is a Prohibited Entity pursuant to SDCL 5-18A-1(19A) but grounds for waiver exist pursuant to SDCL 5-18A-52. *If marking this option, provide the basis for the requested grounds for waiver.*
3. I understand that a Bidder who becomes a Prohibited Entity, as defined above, at any time after making this certification that it is not a Prohibited Entity, Bidder must provide written notice to the District, who may terminate the contract.
4. I understand that the District has the right to terminate a contract with any contractor who submits a false certification, and that any bidder who submits a false certification may be subject to suspension or debarment under SDCL 5-18D-12.

Dated this _____ day of _____, 20____.

(Contractor Business Name)

By: _____

Printed name: _____

Title: _____

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WORK CHANGE DIRECTIVE NO.: [NO. OF WORK CHANGE DIRECTIVE]

Owner:	City of Hill City, SD	Project No.
Owner's Advisor:	AE2S	P12021-2023-005
Engineer:	AE2S	P12021-2023-005
Construction Manager at Risk:	Scull Construction Services, Inc	P12021-2023-005
Project:	Hill City WWTF Improvements	
Contract Name:	Agreement Between Owner and Construction Manager At Risk	
Work Authorization:	Hill City WWTF Improvements	
Date Issued:	Effective Date of Work Change Directive:	

Construction Manager at Risk is directed to proceed promptly with the following change(s):

Description:

[Description of the change to the Work].

Attachments:

[List documents related to the change to the Work].

Purpose for the Work Change Directive:

[Describe the purpose for the change to the Work].

This directive to proceed promptly with the Work described herein, prior to agreeing to change in Contract Price and Contract Time, is issued due to:

☐ Non-agreement on pricing of proposed change. ☐ Necessity to proceed for schedule or other reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Guaranteed Maximum Price:	\$	[increase] [decrease] [not yet estimated].
Contract Time:	days	[increase] [decrease] [not yet estimated].

Basis of estimated change in Contract Price:

☐ Lump Sum ☐ Unit Price ☐ Cost of the Work ☐ Other

Recommended by Engineer	Issued by Owner's Advisor	Authorized by Owner
By:		
Title:		
Date:		

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CHANGE ORDER NO.: [NO. OF CHANGE ORDER]

		Project No.
Owner:	City of Hill City, SD	P12021-2023-005
Owner's Advisor:	AE2S	P12021-2023-005
Engineer:	AE2S	P12021-2023-005
Construction Manager at Risk:	Scull Construction Services, Inc	P12021-2023-005
Project:	Hill City WWTF Improvements	
Contract Name:	Agreement Between Owner and Construction Manager At Risk	
Work Authorization:	Hill City WWTF Improvements	
Date Issued: _____	Effective Date of Change Order: _____	

The Contract is modified as follows upon execution of this Change Order:

Reference:

Specification Section(s):

Drawing(s) / Details (s):

Description:

[Description of the change].

Attachments:

[List documents related to the change].

Change in Guaranteed Maximum Price

Original Guaranteed Maximum Price this Work Authorization	_____
Net [Increase] [Decrease] from previously approved Change Orders No. 1 to	
No. [Number of previous Change Order]	_____
Guaranteed Maximum Price prior to this Change Order	_____
[Increase] [Decrease] this Change Order:	_____
Guaranteed Maximum Price incorporating this Change Order:	_____

Change in Contract Times for Work Authorization

- ☐ Work in this Work Authorization has not been designated as a Milestone—CMAR is to complete Work in this Work Authorization so the Work as a whole will reach Substantial Completion by the date designated in the Agreement.
- ☐ Work in this Work Authorization has been designated as a Milestone—The completion dates for this Work Authorization are modified by this Change Order as shown below.

Substantial Completion Date _____
Final Completion Date _____

Issued by Owner’s Advisor

Authorized by Owner

By: _____
Title: _____
Date: _____

Recommended by Engineer (if required)

Approved by Funding Agency (if applicable)

By: _____
Title: _____
Date: _____

FIELD ORDER NO.: [NO. OF FIELD ORDER]

		Project No.
Owner:	City of Hill City, SD	P12021-2023-005
Owner's Advisor:	AE2S	P12021-2023-005
Engineer:	AE2S	P12021-2023-005
Construction Manager at Risk:	Scull Construction Services, Inc	P12021-2023-005
Project:	Hill City WWTF Improvements Project	
Contract Name:	Agreement Between Owner and Construction Manager At Risk	
Work Authorization:	Hill City WWTF Improvements	
Date Issued: _____	Effective Date of Field Order: _____	

Construction Manager at Risk is hereby directed to promptly perform the Work described in this Field Order, issued in accordance with Paragraph 11.04 of the General Conditions, for minor changes in the Work without changes in the Guaranteed Maximum Price or Contract Times. If Construction Manager at Risk considers that a change in Guaranteed Maximum Price or Contract Times is required, submit a Change Proposal before proceeding with this Work.

Reference:

Specification Section(s):

Drawing(s) / Details (s):

Description:

[Description of the change to the Work]

Attachments:

[List documents supporting change]

Approved by Engineer

Issued by Owner's Advisor

By (signature): _____

Name (printed): _____

Title: _____

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SECTION 00 31 32
GEOTECHNICAL DATA

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes:

1. Soils Investigation Data: Soil and subsurface investigations conducted at site by an independent testing laboratory and report with log of borings prepared.
2. Report obtained for Engineers' design use only.
3. Copy of report follows this Section.

1.02 SOILS INVESTIGATION DATA

A. Soil and Subsurface investigations were conducted at site. Investigation results are documented in a report prepared by:

1. American Engineering Testing, AET, for the City of Hill City and the proposed Hill City WWTF Improvements; AET Project No.P-0044392,dated October 22, 2025.

B. Soils investigation report and data are available for information and convenience of Bidders, and is not warranted to indicate actual conditions.

C. Soils investigation and report are not part of the Contract Documents.

1.03 BIDDER INVESTIGATION

A. Bidders are responsible for reviewing the report(s), visiting the site, and becoming familiar with site conditions.

B. Bidder may, at Bidder's own expense and prior to bidding, make soil surveys, and investigations Bidder considers necessary to bid and perform the work.

C. Bidder assumes risk that the soil and underground conditions may be other than that indicated in soil investigation data.

D. Bidder shall obtain authorization from Owner prior to start of borings or subsurface investigations. Immediately upon completion of Bidder subsurface investigation, return site areas affected by investigations to condition existing prior to start of Bidder subsurface investigations as directed by Owner.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 00 31 32



**Report of Geotechnical Exploration
Proposed Hill City Wastewater Treatment
Facility Improvements**
Hill City, South Dakota

AET Project No. P-0044392

Date:
October 22, 2025

Prepared for:
City of Hill City
P.O. Box 395
Hill City, South Dakota 57745

Geotechnical • Materials
Forensic • Environmental
Building Technology
Petrography/Chemistry

American Engineering Testing
1745 Samco Road
Rapid City, South Dakota 57702
TeamAET.com • 605.388.0029



October 22, 2025

City of Hill City
P.O. Box 395
Hill City, South Dakota 57745

Attn: Mr. Nate Anderson, City Administrator

RE: Report of Geotechnical Exploration
Proposed Hill City Wastewater Treatment Facility Improvements
Hill City, South Dakota
AET Project No. P-0044392

Dear Nate,

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for the above referenced project to be constructed at the Hill City Wastewater Treatment Facility (WWTF) near Hill City, South Dakota. These services were performed in general accordance with our proposal dated June 17, 2025, and written authorization to proceed provided on June 23, 2025. We are submitting one (1) electronic copy of the report to you and as well as one (1) electronic copy to Mr. Zac Ranisate (AE2S).

Please contact me if you have any questions about the report. I can also be contacted to arrange observation and testing services during construction of the project.

Sincerely,
American Engineering Testing, Inc.

Wyatt Leadens, EIT
Engineer II
wleadens@teamaet.com
Phone: (605) 388-0029



SIGNATURE PAGE

Prepared for:

City of Hill City
P.O. Box 395
Hill City, South Dakota 57745

Attn: Mr. Nate Anderson

Prepared by:

American Engineering Testing, Inc.
1745 Samco Road
Rapid City, South Dakota 57702
(605) 388-0029
www.teamAET.com

Authored by:

A handwritten signature in blue ink, appearing to read 'Wyatt Leadens'.

Wyatt Leadens, EIT
Engineer II

Reviewed by:

A handwritten signature in blue ink, appearing to read 'Walt Feeger'.

Walt Feeger, PE
Principal Engineer – West Division

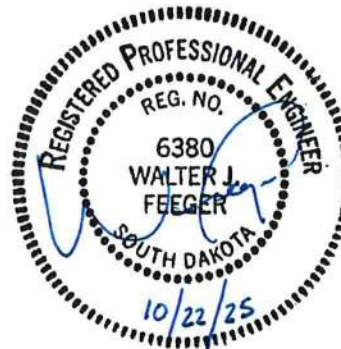




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Geotechnical Field Exploration and Testing
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Preliminary Site Layouts
Subsurface Boring Logs
Unconfined Compression Test Results
Swell-Consolidation Test Reports
Moisture-Density Relationship (Proctor) Test Report
California Bearing Ratio (CBR) Test Report
Laboratory Analytical Reports

APPENDIX B

Geotechnical Report Limitations and Guidelines for Use



1.0 INTRODUCTION

We understand improvements to the existing wastewater treatment facility (WWTF), which services Hill City, South Dakota, have been proposed. Please refer to Figure 1: Boring and Sample Location Map within Appendix A for the location of the site. To assist with the planning and design, American Engineering Testing, Inc. (AET) has been authorized to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services and provides our engineering recommendations based on this data.

2.0 SCOPE OF SERVICES

AET's services were performed in general accordance with our proposal dated June 17, 2025. The authorized scope consists of the following:

- Perform eleven (11) Standard Penetration Test (SPT) borings at the following locations and depths, or practical auger refusal, whichever is less:
 - Proposed New Structures – Six (6) borings (Borings B-1 to B-6) to depths of approximately 35 feet below grade.
 - Pavement – Five (5) borings (Borings B-7 to B-11) to depths of approximately 5 feet below grade.
- Collection of three (3) composite soil samples in the upper five (5) feet, located within the existing Pond No. 2, and analysis of the samples for the presence and concentration of polychlorinated Biphenyls (PCBs).
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

These services are intended for geotechnical purposes only. The scope is not intended to explore for the presence or extent of environmental contamination in the soil or groundwater.

3.0 PROJECT INFORMATION

Based on the information provided, we understand the City of Hill City is proposing to expand the existing WWTF from a peak flow 0.6 MGD to 1.2 MGD to accommodate future population growth and meet updated regulatory requirements.



The project will consist of a new concrete slab-on-grade Preliminary Treatment Building (PTB) with a height of approximately 15 feet, new Sequencing Batch Reactors (SBRs) consisting of 20-foot-deep tanks and a building height of 15 feet above grade, and a new Clarifloculator Expansion consisting of 20-foot-deep tanks and a building height of approximately 15 feet above grade. The project site infrastructure will also include underground utilities, yard piping and paved access drives.

It is our understanding that the exact locations of the structures have not been decided at the time of this report. Four preliminary site layout options are being considered and have been provided in Appendix A of this report.

The purpose of the geotechnical study was to determine the subsurface conditions within the proposed addition areas and to evaluate the suitability of the site soils for their use in constructing the proposed structures, utilities, and associated paving.

The previously stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

The subsurface exploration program conducted for the project consisted of eleven (11) standard penetration test (SPT) borings which were drilled on July 17, 18 and 21, 2025 and three (3) polychlorinated Biphenyls (PCB's) samples, which were collected from the existing Pond No. 2 on July 18, 2025. The borings were drilled and PCB samples taken at locations selected by AET personnel based on a provided preliminary site layout and project information. Please note that due to the presence of hard schist bedrock, practical auger refusal was encountered in Borings B-2 to B-6 at depths ranging from about 21½ feet to 32½ feet below grade.

The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic origins, and moisture condition. A density description or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value).



The boring and PCB sample locations are shown on Figure 1: Boring and Sample Location Map included in Appendix A. Surface elevations at the boring locations were referenced to a Temporary Bench Mark (TBM). The TBM selected for this project was the southernmost corner of the existing plant building located nearest the substation site. For purposes of this report, an assumed elevation of 100.00 were assigned to the TBM.

4.2 Laboratory Testing

The laboratory test program included natural moisture content, dry density, Atterberg Limits, percent passing the #200 sieve, unconfined compression, swell-consolidation, pH, resistivity, moisture-density relationship (Proctor), and California Bearing Ratio (CBR). The test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed or on the data sheets following the boring logs.

The CBR test was remolded to approximately 95% of maximum dry density at the optimum moisture content for the specific boring/material. Results are summarized as follows:

Boring	Depth, ft	Soil Classification	Optimum Moisture Content, % ¹	Maximum Dry Density, pcf ¹	CBR Value ²
B-8	1-5	Lean Clay with Sand (CL)	16.9	104.7	3.5

¹ Based on ASTM D698 (standard Proctor) ² Based on ASTM D1883

It should be noted that the bulk soil samples represent a mixture of the soils encountered within the upper 5-foot interval of each of the boreholes. As such, the soil classification as presented on the Moisture-Density Relationship and CBR data sheets may differ from the classifications of the individual soil layers identified on the respective Subsurface Boring Logs.

Laboratory analysis of pH and resistivity tests were also performed on selected soil samples with the results summarized as follows:

Boring	Depth, ft	Soil Type	pH	Resistivity, Ohm-cm	Corrosion Potential
B-1	10	Sandy Lean Clay (CL)	7.57	1,800	Severe
B-5	1-5	Lean Clay with Sand (CL)	8.64	750	Severe



The corrosion potentials provided are based on information published in the Department of the Army's Technical Manual TM 5-811-7 "Electrical Design, Cathodic Protection". Based on this information, the site soils, as tested in the borings, have a severe range of corrosion potential towards iron and other buried metals. If corrosion of buried metal is critical, it should be protected using a non-corrosive backfill, wrapping, coating, sacrificial anodes, or a combination of these methods, as designed by a qualified corrosion engineer.

The swell/consolidation test is commonly performed to evaluate the swell or consolidation potential of soils or bedrock. In this test, relatively undisturbed samples obtained directly from the ring barrel sampler are placed in a laboratory device and saturated under a predetermined load. The swell-index is the resulting amount of swell (+) as a percent of the sample's thickness after the saturation period. Conversely, the consolidation index is the amount of consolidation (-) as a percentage of the sample's thickness after consolidation under the confining load. Test results are summarized as follows:

Boring	Depth, ft	Soil/Bedrock Type	Swell (+) or Consolidation (-) Potential, %	Swell Pressure, psf
B-2	15	Sandy Lean Clay (CL)	-0.2	NA
B-5	10	Silty Lean Clay with Sand (CL)	-0.2	NA

Based on the laboratory test results, the subsurface lean clays at this site, where tested, have low swell/collapse potential in relation to the proposed improvements. The results of the swell-consolidation test are included in Appendix A of this report.

Polychlorinated Biphenyls (PCB) soil samples were collected at three (3) locations, from the top five feet of Pond No. 2, using composite hand sampling methods. The soil samples were collected in laboratory prepared sealable glass soil jars. The PCB soil samples were submitted to Mid-Continent Testing Laboratories, Inc. on July 21, 2025. PCB analyses were performed in accordance with analysis Method SW8082A and no PCBs were detected in the soil samples at concentrations above the respective analyte reporting limits. Please refer to the Laboratory Analytical Reports provided in Appendix A for a summary of the analytical results.



5.0 SITE CONDITIONS

5.1 Surface Observations

At the time of our field work, the site consisted of the existing wastewater treatment facility utilized by the city of Hill City, South Dakota. The site included a gravel access road to the existing plant and substation site. The existing building had concrete access pads and aprons on the south and east sides of the facility. Access around the existing Pond No. 2 consisted an unpaved two-track road. In general surface drainage tended towards the nearest pond locations and northeast towards Spring Creek. The pond was heavily vegetated with native grasses and cattails.

5.2 Subsurface Soils/Geology

In general, the surfacing material consisted of gravel sections, concrete pavements, and topsoil. No surfacing material was encountered at the location of Boring B-6. The subsurface soils encountered within the borings consisted of alluvium underlain by Metamorphosed Tuffaceous Shale bedrock. The alluvium encountered within the borings consisted of variable consistency/relative density, lean clays with varying amounts of sand and silt, silt with varying amounts of sand, and sand with varying amounts of silt, clay and gravel. The alluvium extended to the termination depths explored in Boring B-7 to B-11.

The Metamorphosed Tuffaceous Shale bedrock was encountered in Borings B-1 to B-6 at depths ranging between 12 and 20 feet and extended to the termination depths explored. The bedrock consisted of interbedded layers of schist rock and sands with varying amounts of clay.

The Subsurface Boring Logs included in Appendix A give a more detailed description of the soils encountered within the borings.

5.3 Groundwater

At the time of our field work, measurable groundwater was encountered in Borings B-1 to B-6, at depths ranging from approximately 12.75 to 20 feet below ground surface. The presence of groundwater noted at the boring locations should not be taken as an accurate representation of the actual groundwater levels. Groundwater levels can fluctuate due to varying seasonal and annual rainfall and snow melt amounts, as well as other factors including local irrigation practices and nearby drainages.



At this time, we have not been provided with any historical groundwater elevations at or near this site. However, it is our understanding that the groundwater table is anticipated to be significantly above the finish floor elevation. In addition, the project site is located near Spring Creek and therefore groundwater will likely be recharged based on the water elevation of Spring Creek.

Accordingly, dewatering will be a significant challenge during construction of the buildings and utilities below the groundwater table. It is our opinion that the contractor must submit an adequate dewatering plan which will adequately remove and maintain a working area free of pooling and/or standing water. The plan should include an effective water collection and pumping system of sufficient size and capacity to remove and maintain a relatively dry working space.

5.4 Site Seismic Classification

We utilized the subsurface soils/geology conditions encountered at the site, the project location, the American Society of Civil Engineers Publication ASCE 7-10 and the International Building Code (IBC) 2018 to establish a site soil class of “E” and a seismic design category of B for this project site.

We recommend seismic design reference the seismic parameters provided in the table below based on the soil conditions and project location.

Parameter	Value
S_s	0.139
S_1	0.045
F_a	2.5
F_v	3.5
S_{MS}	0.347
S_{M1}	0.158
S_{DS}	0.231
S_{D1}	0.106
T_L	4
PGA	0.068
PGA_M	0.171
F_{PGA}	2.5
I_e	1.25

In general, we encountered very stiff to very soft clays and very loose to dense sands with groundwater measurements as shallow as approximately 12.8 feet below ground elevation.



The presence of non-cohesive soils and groundwater can be conducive to liquefaction; however, due to the low probability of an earthquake with large enough ground accelerations to induce liquefaction, the probability of liquefaction at this site is low.

6.0 RECOMMENDATIONS

6.1 Discussion

Based on the information provided by AE2S, we understand that excavations up to approximately 20 feet will be required to reach design finish floor elevations of the proposed SBR and Clariflocculator structures. The Preliminary Treatment Building (PTB) is anticipated to have conventional frost depth spread footings with a slab-on-grade floor system. In addition, we anticipate that minor surface grading, on the order of about 2 feet or less, will be required to reach the desired site grades.

In general, we encountered clay and sand alluvium with prominent schist lenses within the construction elevations. Hard schist lenses were typically encountered at least 12 feet below ground surface. The contractor should anticipate difficulty when excavating these layers. They may require the use of large excavators equipped with rock teeth or pneumatic hammers blasting to reach desired construction elevations.

Schist lenses will likely create an uneven working platform near the desired finish-floor elevations for the SBR and Clariflocculator buildings. It is our opinion that reconditioned and compacted imported granular engineered fill or lean concrete flowable fill may be used to develop a uniform bearing surface, where required.

For excavations, it is our opinion the site alluvial soils should be classified as Type C soils with recommended slope laybacks of 1.5H:1V. We have assumed temporary shoring and bracing will not be required due to the depth of foundations of the existing building near the proposed building locations.

Groundwater was encountered in Borings B-1 to B-6 at depths ranging from approximately 12.8 to 20 feet below the existing ground surface. Therefore, we anticipate groundwater will be encountered in the excavations required for construction of the proposed structures and/or utility excavations. We recommend the contractor provide a de-watering plan prior to excavation work taking place and should be responsible for monitoring during excavation work. The dewatering plan should adequately remove and maintain a working area free of pooling or standing water. The plan must include an effective water collection and pumping system of sufficient size and capacity to remove and maintain a relatively dry working space.



It is our opinion, typical sump pumping method will not be adequate due to the proximity to Spring Creek and presence of highly permeable layers encountered in the borings.

A potential side effect of any dewatering effort is settlement (consolidation) of the soils, resulting in surface settlements, which can adversely impact existing structures, pavements or underground facilities.

The contractor should select a dewatering system that will limit the cone of groundwater depression to the immediate construction area. As noted, we recommend the contractor provide a de-watering plan prior to excavation work taking place and should be responsible for monitoring during excavation work. The contractor should also submit a plan for monitoring and documenting whether or not the dewatering results in surface settlements beyond the immediate construction area.

Such a plan typically consists of establishing a system of elevation monitoring points on the ground and on nearby structures, and performing a pre-construction crack survey to document the condition of existing structures as well as documenting the groundwater elevation at nearby domestic water wells, if present. The monitoring points and well water elevations should be monitored frequently during construction so that impacts can be promptly identified and mitigating action taken.

If the monitoring indicates the dewatering or construction method used is impacting nearby structures or causing a significant reduction in the water elevation of nearby wells, other methods of construction and/or groundwater control should be immediately implemented, or provisions for repairing the impacts should be made by the contractor.

Our recommendations in the following sections are intended to minimize, to varying degrees, movement related problems associated with the proposed foundations and floor slabs. Even if our recommendations are followed, we cannot guarantee that some movement will not occur. The present state of the art is such that the risk of movement cannot be accurately assessed. It depends on a number of uncontrolled variables such as climatic conditions during and after construction, long term fluctuations of the groundwater level, utility line leakage, landscaping, and other similar aspects. The risk of detrimental movement must be assumed by the project owner.

6.2 Site Preparation

Based on site topography, minor cut and fill balances will likely be required within the proposed structure footprints in order to reach the desired grade elevations.



We recommend all organic matter, topsoil, concrete or gravel sections, and any construction/manmade debris, if encountered, be removed from within the construction limits. Excavations should continue to the design grade and structure elevations.

Conventional large construction equipment, such as tracked excavators, should be able to make the required cuts into the site soils. Please note that deeper excavations will likely encounter schist layers, which may require rock teeth and pneumatic hammers to facilitate removal of the material. The excavated soils, cleaned of all unsuitable materials and aggregate greater than 3-inches in nominal size, may be stockpiled on-site and reused as overlot fill and utility trench/exterior wall backfill.

Prior to placement of structural elements or base course, we recommend that, to the extent practical, the exposed subgrade soils be scarified to a depth of at least 8-inches, the moisture content adjusted to near optimum, and the soils compacted to at least 95 percent of the maximum dry density, as determined by ASTM D698 (standard Proctor). All exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

This process will help to delineate soft or disturbed areas. Unstable areas identified during scarification and compaction should either be stabilized or undercut to expose stable material. If isolated soft or unstable areas are encountered, it may be necessary to place a layer of crushed stone to stabilize the subgrade and help expedite construction.

Schist layers will likely produce an uneven bearing surface at design finish floor elevations. Where encountered, we recommend utilizing imported granular engineered fill. The imported granular engineered fill, placed below the monolithic slab should be a non-expansive material with a maximum aggregate size of 2-inches, 40 to 85% passing the No.4 sieve, and no more than 15% passing the No.200 sieve with a Liquid Limit less than 25. Prior to use, the moisture content should be adjusted to within $\pm 3\%$ of optimum, the material placed in 8-inch thick maximum loose lifts, and compacted to at least 98% of the maximum dry density as determined by ASTM D698 (standard Proctor). As a construction expedient, a lean concrete flowable fill material (mud mat) may be utilized to create a level working surface.

All overlot fill material placed to reach the desired design subgrade elevations should be moisture conditioned and compacted in accordance with Section 6.5 "Backfill Considerations" of this report. Please note that, based on the laboratory test results, processing and moisture conditioning of these soils before their re-use should be anticipated.



Means and methods of attaining the required moisture content and workability of the material should be left to the discretion of the earthwork contractor, but high moisture content soils should not be deemed 'unsuitable' for use.

6.3 Foundation Recommendations

It is our opinion the SBR and Clarifluculator can be supported on reinforced concrete monolithic slabs bearing on the reconditioned site soils at a depth of approximately 20 feet below existing grade. The PTB building can be supported on conventional spread footings and a slab-on-grade floor bearing on a minimum of 3 feet of imported granular engineered fill.

Where applicable, we recommend imported granular engineered fill be utilized to develop a uniform bearing surface at design finish floor elevations if site grading requires removal of shist layers and under conventional spread footings. As a construction expedient, a lean concrete flowable fill (mud mat) with a minimum 28-day compressive strength of 150 psi may be used in lieu of imported engineered fill below the SPR and Clariflocculator Expansion.

We highly recommend the base of the foundation excavations be observed and properly compacted to verify a firm and unyielding subgrade has been obtained on which to place the structural elements. It is our opinion, a modulus of subgrade reaction of 125, 200 and 250 pounds per cubic inch can be used for the site alluvial clays, schist and sands of the Metamorphosed Tuffaceous Shale and imported granular engineered fill, respectively.

Where spread footings are required to support building loads, exterior footings, interior footings in unheated portions of the building, or footings placed during freezing conditions should be placed at least 4 feet below final grades for frost protection. Interior footings in heated portions of the building may be placed directly below the floor slab. We recommend utilizing the bearing compacity presented in the sections below. Structure specific recommendations are presented in the following sections:

6.3.1 SBR and Clariflocculator Expansion

We understand a reinforced monolithic slab at a finish floor elevation approximately 20 feet below grade have been proposed for the SBR and Clariflocculator. The foundation may be designed for an allowable bearing capacity of 3,000 pounds per square foot (psf). As designed, loadings should provide a theoretical safety factor of three or more with respect to a general shear or base failure of the footings. The monolithic slab should be designed by a structural engineer to take this into account as well as the anticipated wall loads.



If properly constructed, total and differential movement should not exceed 1 inch and 1/2-inch, respectively.

6.3.2 Preliminary Treatment Building

We understand that conventional frost depth spread footings and a slab-on-grade floor are proposed for the PTB. Both elements should bear on a minimum of 3 feet of imported granular engineered fill over the recompacted subgrade soils. The imported granular engineered fill, placed below the monolithic slab, should be a non-expansive material with a maximum aggregate size of 2-inches, 40 to 85% passing the No.4 sieve, and no more than 15% passing the No.200 sieve with a Liquid Limit less than 25.

The foundation may be designed for an allowable bearing capacity of 1,500 pounds per square foot (psf). As designed, loadings should provide a theoretical safety factor of three or more with respect to a general shear or base failure of the footings. Total and differential movement should not exceed 1 inch and 1/2-inch, respectively.

We recommend the floor slab be constructed independent of the foundations, in the event some movement does occur. A leveling course, typically 4 to 6 inches of a granular material provided below the concrete slab, is placed to prevent capillary moisture rise to the slab. This granular fill should contain less than 12% by weight passing the #200 sieve, and less than 40% passing the #40 sieve. This sand/gravel cushion layer may be considered as part of the 3 feet of granular engineered fill recommended below the floor slab. Please refer to the "Floor Slab Moisture/Vapor Protection" document in the Standard Sheets section at the back of this report for additional information.

6.4 Exterior Concrete Flatwork

Exterior concrete flatwork typically consists of 4 to 6-inches of concrete placed on aggregate base course. Increased moisture contents of the clay soils present on site, due to drainage and/or seasonal weather, may result in upward movement of these slabs and sidewalks especially during colder weather.

While this upward movement may not immediately or directly affect the integrity of the building foundations and interior slabs, over time positive drainage away from the building may be lost. In addition, upward movement tends to cause distress cracks and potential tripping hazards. To minimize these potential issues, we recommend placement of a majority of these exterior slabs and sidewalks on at least one (1) foot of aggregate base course for a distance of at least 10 feet from the building.



6.5 Backfill Considerations

It is our opinion that the site soils may be re-used as utility trench backfill, exterior wall backfill, and as overlot fill required to reach the general site grade elevations. Based on the existing moisture content of the site soils, processing of the material will likely be required prior to re-use. All recommendations are based on the standard Proctor method (ASTM D698).

1. All backfill should be free of deleterious/frozen material, and construction debris, and have a maximum aggregate size of 3-inches.
2. Cohesive (clay) backfill should be moisture conditioned to within -1 to +3% of optimum moisture content prior to being placed. Granular backfill (sands and gravels) should be moisture conditioned to within $\pm 3\%$ of optimum moisture content prior to being placed.
3. All backfill should be placed in loose lift thicknesses of 8-inches or less. If hand-operated compaction equipment is used, the loose lift thickness should be reduced to 4-inches or less.
4. Each lift should be compacted to at least 95% of maximum proctor density. We recommend for wall heights exceeding 10 feet in height and the top 1 foot below pavements the backfill be compacted to at least 98% of the maximum dry density.
6. Compaction density tests should be performed on alternating lifts to ensure the minimum density is maintained.
7. Utility lines entering or exiting the structures should be leak tested prior to the placement of the slab.

Should additional fill be required, the proposed import backfill should be submitted to the geotechnical engineer for approval prior to use.

6.6 Utility Construction

It is our opinion that excavated site soils cleaned of unsuitable materials and aggregate greater than 3-inches in nominal size are suitable for re-use as trench backfill. We recommend utilities that are frost susceptible be buried at least 6 feet below grade for frost protection.

If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov).



Even with the required OSHA sloping, water seepage or surface runoff can potentially induce side slope erosion or running which could require slope maintenance. For trench excavations, it is our opinion the site alluvial soils should be classified as Type C soils with recommended slope laybacks of 1.5H:1V. This classification should be considered preliminary and should be verified in the field on a daily basis by the contractor and/or geotechnical engineer.

Excavations deeper than 20 feet and/or in saturated soils or below the ground water table should be considered on an individual basis. Water levels, due to climatic conditions, should be evaluated at the time of construction. If the above trench layback recommendations are not feasible, due to space limitations or other factors, the OSHA rules should be consulted for alternative trench stabilization methods. Trench boxes or shoring in compliance with OSHA rules may be acceptable alternatives.

Additionally, as previously noted, groundwater was encountered in our borings at the time of our field work. Therefore, we highly recommend the earthwork contractor anticipate the need to dewatering the excavations and provide a dewatering plan to adequately remove and maintain a relatively dry working area.

6.7 Lateral Earth Pressures

We understand that permanent cast-in-place walls and buried tanks, will need to be designed to accommodate the lateral earth pressures presented below.

Cleaned and approved site soils or imported material may be used as the remainder of the backfill behind the walls. We have assumed that the site soils will be reused as backfill material. Compaction of the backfill should be accomplished with hand-operated tampers or other lightweight compactors. Over-compaction may cause excessive lateral earth pressures which could result in unexpected wall movements.

The following soil parameters should be considered in the design and construction of the basement walls and buried tanks:

- Coefficient of Friction
 - Site alluvial clay soils 0.25
 - Site alluvial sand soils..... 0.35
 - Imported granular engineered fill 0.45



- Friction Angle
 - Site alluvial clay soils 18°
 - Site alluvial sand soils 22°
 - Imported granular engineered fill 36°
- Moist Unit Weight
 - Site clay alluvial soils 115 pcf
 - Site sand alluvial soils 120 pcf
 - Imported granular engineered fill 130 pcf

For soils above any free water surface, recommended equivalent fluid pressures for foundation elements are:

- Active (unrestrained):
 - Site alluvial clay soils 60 psf/ft
 - Site alluvial sand soils 55 psf/ft
 - Imported granular engineered fill 35 psf/ft
- Passive (unrestrained):
 - Site alluvial clay soils 215 psf/ft
 - Site alluvial sand soils 260 psf/ft
 - Imported granular engineered fill 500 psf/ft
- At Rest (restrained):
 - Site alluvial clay soils 80 psf/ft
 - Site alluvial sand soils 75 psf/ft
 - Imported granular engineered fill 55 psf/ft

For soils above below free water surface, recommended equivalent fluid pressures for foundation elements are:

- Active (unrestrained):
 - Site alluvial clay soils 90 psf/ft
 - Site alluvial sand soils 90 psf/ft
 - Imported granular engineered fill 80 psf/ft
- Passive (unrestrained):
 - Site alluvial clay soils 160 psf/ft
 - Site alluvial sand soils 190 psf/ft
 - Imported granular engineered fill 325 psf/ft



- At Rest (restrained):
 - Site alluvial clay soils 100 psf/ft
 - Site alluvial sand soils 100 psf/ft
 - Imported granular engineered fill 90 psf/ft

6.8 Pavements

No traffic information was provided for use in our design analysis. However, we have assumed moderate traffic along the proposed access road to include maintenance trucks as well as delivery vehicles and semi-tractor trailers. Therefore, an equivalent 20-year design 18-kip single axle load (ESAL) of 100,000 was used in our analysis.

The 20-year design period is considered to be the interval over which, with proper maintenance, the pavement will not require major repairs. A continuing regular maintenance program should be implemented to maintain satisfactory serviceability over the design life. The maintenance program should include sealing cracks and repairing minor deficiencies. Please notify us if any of the parameters used in the pavement design do not adequately define the anticipated conditions.

6.8.1 Considerations

The following pavement sections are designed based on the procedures outlined in the 1993 AASHTO Empirical Equation for Flexible Pavements and Rigid Pavements. We have assumed all pavements within this project scope will be moderately travelled. We have assumed that site soils will be used as grading material, and therefore, it is anticipated that pavement subgrade soils will predominately consist of lean clay soils.

Based on the laboratory test results, the calculated CBR value from Boring B-8 was 3.5, which we have used with the following design parameters:

Parameter	Asphalt	Concrete
Design Life, years	20	20
Resilience Modulus (M_R)	1500 x CBR	1500 x CBR
Initial Serviceability	4.2	4.5
Design Deviation	0.45	0.35
Terminal Serviceability	2.5	2.0
Drainage Coefficient	1.0	1.0
AASHTO Design Reliability	75%	75%
18 kip ESAL	100,000	100,000

6.8.2 Subgrade Preparation

Prior to placement of base course/new pavement along the proposed roadway alignment, the exposed subgrade soils should be scarified to a depth of 8-inches, the moisture content of the scarified soils adjusted to near optimum moisture content and the material compacted to at least 95% of maximum standard Proctor dry density (ASTM D698).

This scarification process may need to be repeated over several days in order to allow the soils to dry back to an acceptable moisture content. The earthwork contractor should be made aware of the soil conditions at the site and account for the anticipated subgrade preparation work.

If project schedules do not allow for sufficient time to dry the soil back to acceptable levels, use of a geo-textile stabilization/separation material can be incorporated in the design. The geo-textile should be placed on top of the graded subgrade and below the aggregate base course layer. Please note the pavement section, including base course thickness, may be subject to change if incorporating a geo-textile stabilization material into the design.

All prepared subgrades should be proof rolled with a loaded dump truck or similar weighted construction equipment to verify a firm and unyielding subgrade has been obtained prior to the placement aggregate base course materials. Any areas that "pump" under the loaded construction equipment should be evaluated by the engineer to determine whether additional excavation and replacement with a coarse, clean rock or the use of a geo-textile fabric should be used to stabilize the subgrade. Once the subgrade has been proof rolled and approved by the geotechnical engineer, base course may be placed.

6.8.3 Aggregate Base Course

Aggregate base course should be moisture conditioned to within $\pm 3\%$ of optimum and compacted to a minimum of 95% of the maximum dry density as determined by ASTM D698 (standard Proctor) and should meet the requirements as outlined in Section 882 "Aggregates for Granular Bases and Surfacing" of the SDDOT specifications, current edition.



6.8.4 Pavement Recommendations

Based on the previously described design parameters and our analysis, we recommend the following minimum pavement sections be used for this project:

Recommended Pavement Section Thickness			
Rigid (Concrete), in	Flexible (Asphalt), in	Aggregate Base Course, in.	Total, in.
6	-	6	12
-	5	8	13

We recommend the asphalt be obtained from an approved mix design conforming to the South Dakota Department of Transportation (SDDOT) Specifications as defined in Sections 320 and 321 of the “Standard Specifications for Road and Bridges”, current edition.

Where rigid pavements are used, the concrete should be obtained from an approved mix design conforming to Sections 380 “Portland Cement Concrete Pavement” and 460 “Structural Concrete” of the SDDOT Standard Specifications for Roads and Bridges, current edition.

Longitudinal and transverse joints should be provided as needed in concrete pavements for expansion/contraction and isolation. The location and extent of joints should be based upon the final pavement geometry. Sawed joints should be cut within 24-hours of concrete placement. All joints should be sealed to prevent entry of foreign material and dowelled where necessary for load transfer.

If a high modulus geotextile, such as Mirafi RS380i, or approved equivalent, is placed on the prepared subgrade, for separation and reinforcement purposes, the thickness of basecourse within the recommended asphalt pavement section can typically be reduced by about 25 percent. If a geotextile separation/stabilization fabric or a geogrid is used, we recommend you contact the manufacturer for design parameters and additional considerations for the pavement section.

Mix designs should be submitted prior to construction to verify their adequacy.



6.8.5 Pavement Maintenance

The pavement section provided in this report represents a minimum recommended thickness and, as such, periodic maintenance should be anticipated. Therefore, preventive maintenance should be planned and provided for through an on-going pavement maintenance program. Preventive maintenance activities are intended to slow the rate of pavement deterioration. Pavement maintenance consists of both localized maintenance (crack and joint sealing and patching) and global maintenance (surface sealing).

Preventive maintenance is usually the first priority when implementing a planned pavement maintenance program and provides the highest return on investment for pavements. Prior to implementing any maintenance program, additional engineering input is recommended to determine the type and extent of preventive maintenance appropriate. Even with periodic maintenance, some movements and related cracking may still occur and repairs may be required.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Difficulties

7.1.1 Very Dense Bedrock

Schist layers were encountered across the site. During field exploration these resulted in auger refusal particularly in the area near the existing building. The excavation contractor should anticipate difficulty near the bottom of deeper excavations. We anticipate schist can be excavated using large construction equipment. However, the use of rock teeth, pneumatic hammers, and potentially minor blasting may be required to facilitate the excavation of the material. In addition, schist may necessitate over excavation within the footprint of the proposed structures and/or utility trenches for removal.

7.1.2 Groundwater and Runoff Water in Excavation

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we do not anticipate the groundwater can be handled with conventional sump pumping.



We recommend the contractor provide a de-watering plan prior to excavation work taking place and should be responsible for monitoring during excavation work. The dewatering plan should adequately remove and maintain a working area free of pooling or standing water. The plan must include an effective water collection and pumping system of sufficient size and capacity to remove and maintain a relatively dry working space.

7.1.3 Disturbance of Soils

The on-site soils can be disturbed under construction traffic, especially if the soils are wet. If soils become disturbed, they should be subcut to the underlying undisturbed soils. The subcut soils can then be dried and recompact back into place, or they should be removed and replaced with drier imported fill.

7.2 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by a geotechnical engineer/technician during construction to evaluate these potential changes. Soil density testing should also be performed on new fill placed in order to document that project specifications for compaction have been satisfied.

8.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, we have endeavored to provide our services according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, expressed or implied, is intended. Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use."

Report of Geotechnical Exploration
Hill City WWTF Improvements – Hill City, South Dakota
August 14, 2025
AET Project No. P-0044392



Standard Sheets

FLOOR SLAB MOISTURE/VAPOR PROTECTION

Floor slab design relative to moisture/vapor protection should consider the type and location of two elements, a granular layer and a vapor membrane (vapor retarder, water resistant barrier or vapor barrier). In the following sections, the pros and cons of the possible options regarding these elements will be presented, such that you and your specifier can make an engineering decision based on the benefits and costs of the choices.

GRANULAR LAYER

In American Concrete Institute (ACI) 302.1-96, a "base material" is recommended, rather than the conventional cleaner "sand cushion" material. The manual maintains that clean sand (common "cushion" sand) is difficult to compact and maintain until concrete placement is complete. ACI recommends a clean, fine graded material (with at least 10% to 30% of particles passing a #100 sieve) which is not contaminated with clay, silt or organic material. We refer you to ACI 302.1-96 for additional details regarding the requirements for the base material.

In cases where potential static water levels or significant perched water sources appear near or above the floor slab, an underfloor drainage system may be needed wherein a daintile system is placed within a thicker clean sand or gravel layer. Such a system should be properly engineered depending on subgrade soil types and rate/head of water inflow.

VAPOR MEMBRANE

The need for a vapor membrane depends on whether the floor slab will have a vapor sensitive covering, will have vapor sensitive items stored on the slab, or if the space above the slab will be a humidity controlled area. If the project does not have this vapor sensitivity or moisture control need, placement of a vapor membrane may not be necessary. Your decision will then relate to whether to use the ACI base material or a conventional sand cushion layer. However, if any of the above sensitivity issues apply, placement of a vapor membrane is recommended. Some floor covering systems (adhesives and flooring materials) require a vapor membrane to maintain a specified maximum slab moisture content as a condition of their warranty.

VAPOR MEMBRANE/GRANULAR LAYER PLACEMENT

A number of issues should be considered when deciding whether to place the vapor membrane above or below the granular layer. The benefits of placing the slab on a granular layer, with the vapor membrane placed **below** the granular layer, include **reduction** of the following:

- Slab curling during the curing and drying process.
- Time of bleeding, which allows for quicker finishing.
- Vapor membrane puncturing.
- Surface blistering or delamination caused by an extended bleeding period.
- Cracking caused by plastic or drying shrinkage.

The benefits of placing the vapor membrane **over** the granular layer include the following:

- The moisture emission rate is achieved faster.
- Eliminates a potential water reservoir within the granular layer above the membrane.
- Provides a "slip surface", thereby reducing slab restraint and the associated random cracking.

If a membrane is to be used in conjunction with a granular layer, the approach recommended depends on slab usage and the construction schedule. The vapor membrane should be placed above the granular layer when:

- Vapor sensitive floor covering systems are used or vapor sensitive items will be directly placed on the slab.
- The area will be humidity controlled, but the slab will be placed before the building is enclosed and sealed from rain.
- Required by a floor covering manufacturer's system warranty.

The vapor membrane should be placed below the granular layer when:

- Used in humidity controlled areas (without vapor sensitive coverings/stored items), with the roof membrane in place, and the building enclosed to the point where precipitation will not intrude into the slab area. Consideration should be given to slight sloping of the membrane to edges where daintile or other disposal methods can alleviate potential water sources, such as pipe or roof leaks, foundation wall damp proofing failure, fire sprinkler system activation, etc.

There may be cases where membrane placement may have a detrimental effect on the subgrade support system (e.g., expansive soils). In these cases, your decision will need to weigh the cost of subgrade options and the performance risks.

Appendix A

Geotechnical Field Exploration and Testing
 Boring Log Notes
 Unified Soil Classification System
Figure 1: Boring and Sample Location Map
 Preliminary Site Layouts
 Subsurface Boring Logs
 Unconfined Compression Test Results
 Swell-Consolidation Test Reports
Moisture-Density Relationship (Proctor) Test Reports
 California Bearing Ratio (CBR) Test Report
 Laboratory Analytical Reports

Appendix A

Geotechnical Field Exploration and Testing

AET Project No. P-0044392

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling standard penetration test (SPT) borings. The locations of the borings appear on Figure 1, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS) - Calibrated to N_{60} Values

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586 with one primary modification. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value. Our method uses a modified hammer weight, which is determined by measuring the system energy using a Pile Driving Analyzer (PDA) and an instrumented rod.

In the past, standard penetration N-value tests were performed using a rope and cathead for the lift and drop system. The energy transferred to the split-spoon sampler was typically limited to about 60% of its potential energy due to the friction inherent in this system. This converted energy then provides what is known as an N_{60} blow count.

The most recent drill rigs incorporate an automatic hammer lift and drop system, which has higher energy efficiency and subsequently results in lower N-values than the traditional N_{60} values. By using the PDA energy measurement equipment, we are able to determine actual energy generated by the drop hammer. With the various hammer systems available, we have found highly variable energies ranging from 55% to over 100%. Therefore, the intent of AET's hammer calibrations is to vary the hammer weight such that hammer energies lie within about 60% to 65% of the theoretical energy of a 140-pound weight falling 30 inches. The current ASTM procedure acknowledges the wide variation in N-values, stating that N-values of 100% or more have been observed. Although we have not yet determined the statistical measurement uncertainty of our calibrated method to date, we can state that the accuracy deviation of the N-values using this method is significantly better than the standard ASTM Method.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of "topsoil" layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

Appendix A

Geotechnical Field Exploration and Testing

AET Project No. P-0044392

A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- ♦ Date and Time of measurement
- ♦ Sampled Depth: lowest depth of soil sampling at the time of measurement
- ♦ Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- ♦ Cave-in Depth: depth at which measuring tape stops in the borehole
- ♦ Water Level: depth in the borehole where free water is encountered
- ♦ Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests

Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

A.5.2 Atterberg Limits Tests

Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

A.5.3 Sieve Analysis of Soils (thru #200 Sieve)

Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

A.5.4 Particle Size Analysis of Soils (with hydrometer)

Conducted per AET Procedure 01-LAB-050, which is performed in general accordance with ASTM: D422 and AASHTO: T88.

A.5.5 Unconfined Compressive Strength of Cohesive Soil

Conducted per AET Procedure 01-LAB-080, which is performed in general accordance with ASTM: D2166 and AASHTO: T208.

A.5.6 Laboratory Soil Resistivity using the Wenner Four-Electrode Method

Conducted per AET Procedure 01-LAB-090, which is performed using Soil Box apparatus in the laboratory in general accordance with ASTM: G57

A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
AR:	Sample of material obtained from cuttings blown out the top of the borehole during air rotary procedure.
B, H, N:	Size of flush-joint casing
CAS:	Pipe casing, number indicates nominal diameter in inches
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
DP:	Direct push drilling; a 2.125 inch OD outer casing with an inner 1½ inch ID plastic tube is driven continuously into the ground.
FA:	Flight auger; number indicates outside diameter in inches
HA:	Hand auger; number indicates outside diameter
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symbols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RDA:	Rotary drilling with compressed air and roller or drag bit.
RDF:	Rotary drilling with drilling fluid and roller or drag bit
REC:	In split-spoon (see notes), direct push and thin-walled tube sampling, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run). Zero indicates no sample recovered.
SS:	Standard split-spoon sampler (steel; 1.5" is inside diameter; 2" outside diameter); unless indicated otherwise
SU	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density, pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeability (K) test; F - Field; L - Laboratory
PL:	Plastic Limit, %
q _p :	Pocket Penetrometer strength, tsf (<u>approximate</u>)
q _c :	Static cone bearing pressure, tsf
q _u :	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in percent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remolded (field), psf
VSU:	Vane shear strength, undisturbed (field), psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES (Calibrated Hammer Weight)

The standard penetration test consists of driving a split-spoon sampler with a drop hammer (calibrated weight varies to provide N₆₀ values) and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM: D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

The length of sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the initial 6" set (unless partial penetration defined in ASTM: D1586 is encountered) whereas the length of sample recovered is for the entire sampler drive (which may even extend more than 18").



UNIFIED SOIL CLASSIFICATION SYSTEM

ASTM Designations: D 2487, D2488

AMERICAN
ENGINEERING TESTING,
INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A				Soil Classification		Notes
				Group Symbol	Group Name ^B	
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines ^C	$Cu \geq 4$ and $1 \leq Cc \leq 3^E$	GW	Well graded gravel ^F	^A Based on the material passing the 3-in (75-mm) sieve.
			$Cu < 4$ and/or $1 > Cc > 3^E$	GP	Poorly graded gravel ^F	^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.
		Gravels with Fines more than 12% fines ^C	Fines classify as ML or MH	GM	Silty gravel ^{F,G,H}	^C Gravels with 5 to 12% fines require dual symbols:
			Fines classify as CL or CH	GC	Clayey gravel ^{F,G,H}	GW-GM well-graded gravel with silt GW-GC well-graded gravel with clay GP-GM poorly graded gravel with silt GP-GC poorly graded gravel with clay
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines ^D	$Cu \geq 6$ and $1 \leq Cc \leq 3^E$	SW	Well-graded sand ^I	^D Sands with 5 to 12% fines require dual symbols:
			$Cu < 6$ and $1 > Cc > 3^E$	SP	Poorly-graded sand ^I	SW-SM well-graded sand with silt SW-SC well-graded sand with clay SP-SM poorly graded sand with silt SP-SC poorly graded sand with clay
		Sands with Fines more than 12% fines ^D	Fines classify as ML or MH	SM	Silty sand ^{G,H,I}	
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line ^J	CL	Lean clay ^{K,L,M}	^E $Cu = D_{60} / D_{10}$, $Cc = (D_{30})^2 / D_{10} \times D_{60}$
			PI < 4 or plots below "A" line ^J	ML	Silt ^{K,L,M}	^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.
		organic	Liquid limit—oven dried < 0.75 Liquid limit — not dried	OL	Organic clay ^{K,L,M,N} Organic silt ^{K,L,M,O}	^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.
						^H If fines are organic, add "with organic fines" to group name.
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay ^{K,L,M}	^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.
			PI plots below "A" line	MH	Elastic silt ^{K,L,M}	^J If Atterberg limits plot is hatched area, soils is a CL-ML silty clay.
		organic	Liquid limit—oven dried < 0.75 Liquid limit — not dried	OH	Organic clay ^{K,L,M,P} Organic silt ^{K,L,M,Q}	^K If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.
						^L If soil contains $\geq 30\%$ plus No. 200, predominantly sand, add "sandy" to group name.
Highly organic soil				PT	Peat ^R	^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

SIEVE ANALYSIS

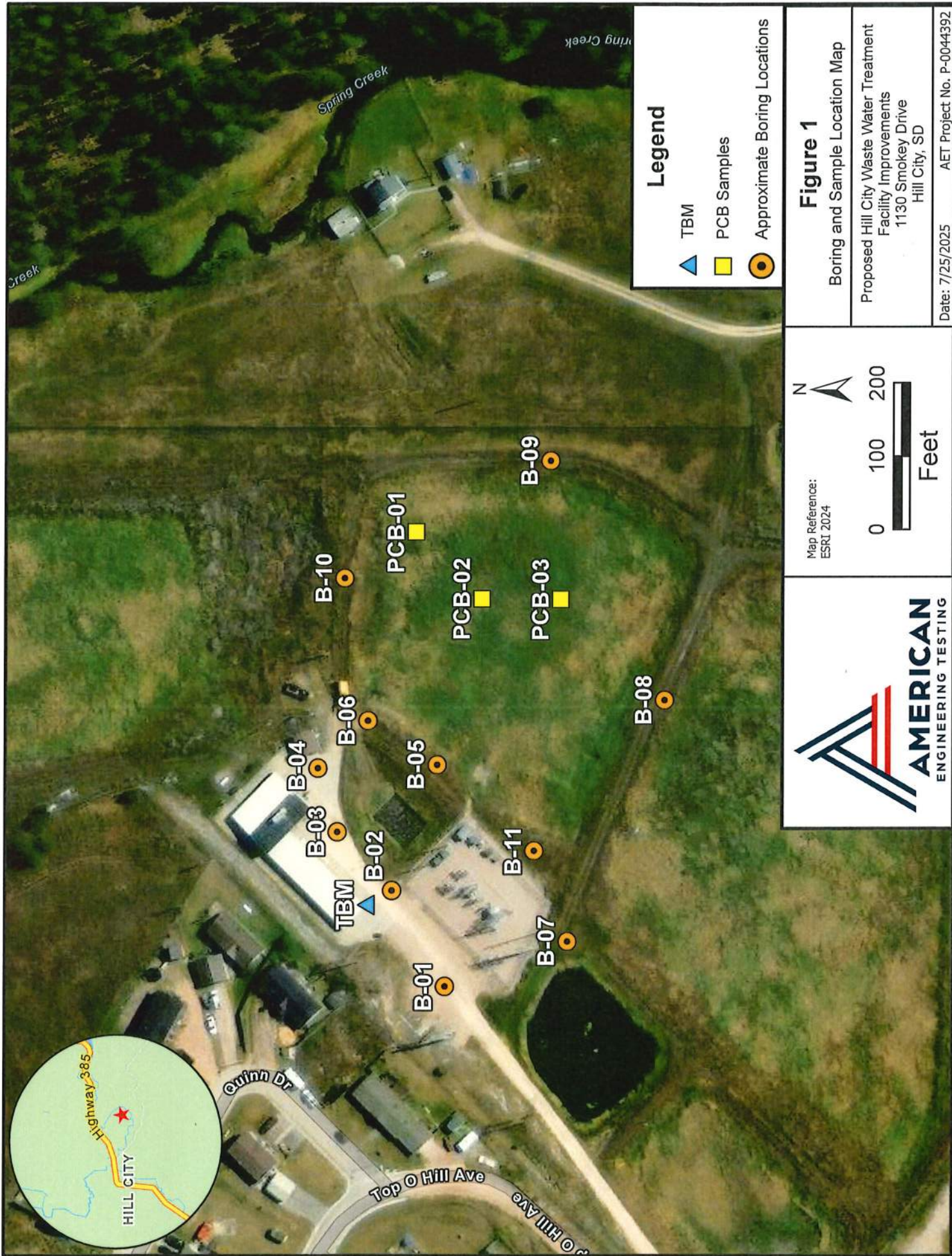
Equation of "A"-line
Horizontal at PI = 4 to LL = 25.5,
then PI = 0.73 (LL-20)

Equation of "U"-line
Vertical at LL = 16 to PI = 7,
then PI = 0.9 (LL-8)

LIQUID LIMIT (LL)
Plasticity Chart

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size		Gravel Percentages		Consistency of Plastic Soils		Relative Density of Non-Plastic Soils	
Term	Particle Size	Term	Percent	Term	N-Value, BPF	Term	N-Value, BPF
Boulders	Over 12"	A Little Gravel	3% - 14%	Very Soft	less than 2	Very Loose	0 - 4
Cobbles	3" to 12"	With Gravel	15% - 29%	Soft	2 - 4	Loose	5 - 10
Gravel	#4 sieve to 3"	Gravelly	30% - 50%	Firm	5 - 8	Medium Dense	11 - 30
Sand	#200 to #4 sieve			Stiff	9 - 15	Dense	31 - 50
Fines (silt & clay)	Pass #200 sieve			Very Stiff	16 - 30	Very Dense	Greater than 50
				Hard	Greater than 30		
Moisture/Frost Condition		Layering Notes		Fiber Content of Peat		Organic/Roots Description (if no lab tests)	
(MC Column)		Laminations: Layers less than 1/2" thick of differing material or color.		Fiber Content (Visual Estimate)		Soils are described as <i>organic</i> , if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. <i>Slightly organic</i> used for borderline cases.	
D (Dry):	Absence of moisture, dusty, dry to touch.			Fibric Peat:	Greater than 67%		
M (Moist):	Damp, although free water not visible. Soil may still have a high water content (over "optimum").			Hemic Peat:	33 - 67%		
W (Wet/ Waterbearing):	Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.	Lenses: Pockets or layers greater than 1/2" thick of differing material or color.		Sapric Peat:	Less than 33%		
F (Frozen):	Soil frozen					With roots: Judged to have sufficient quantity of roots to influence the soil properties.	
						Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.	





Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively



0 40
Scale in Feet

- PRELIMINARY TREATMENT BUILDING
- CLARIFLOCCULATOR EXPANSION
- SBR
- PROPOSED ROAD SURFACE

SHEET TITLE			
SITE LAYOUT OPTION 1			
CLIENT:		CITY OF HILL CITY	
HILL CITY, SD		PREPARED BY: JJF	
PROJECT NO: 12021-2023-005		CHECKED BY: XXX	
DATE: JUNE 2025		APPROVED BY: XXX	
ALT. PROJECT NO: —		SHEET NO: 1	
SHEET DESIGNATOR: EX		PROJECT TITLE	

HILL CITY WWTF IMPROVEMENTS

Advanced Engineering and Environmental Services, LLC www.ae2s.com

STATUS: PRELIMINARY - NOT FOR CONSTRUCTION

APPR

DATE

SYM



0 40
Scale in Feet

-  PRELIMINARY TREATMENT BUILDING
-  CLARIFLOCCULATOR EXPANSION
-  SBR
-  PROPOSED ROAD SURFACE

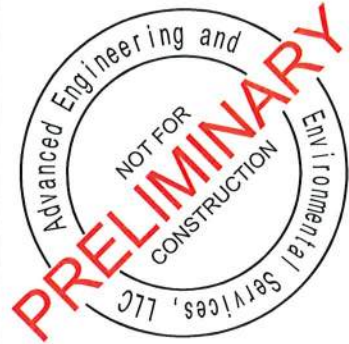
SHEET TITLE SITE LAYOUT OPTION 2			
CLIENT CITY OF HILL CITY HILL CITY, SD		PREPARED BY: JJF CHECKED BY: XXX APPROVED BY: XXX	
PROJECT NO: 12021-2023-005 DATE: JUNE 2025 ALT. PROJECT NO: —	SHEET DESIGNATOR EX	SHEET NO. 2	

STATUS: PRELIMINARY - NOT FOR CONSTRUCTION		
SYM	DATE	APPR

HILL CITY WWTF IMPROVEMENTS



Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively



0 40
Scale in Feet

-  PRELIMINARY TREATMENT BUILDING
-  CLARIFLOCCULATOR EXPANSION
-  SBR
-  PROPOSED ROAD SURFACE

STATUS: PRELIMINARY - NOT FOR CONSTRUCTION

SYM	DATE	APPR

HILL CITY WWTF IMPROVEMENTS

Advanced Engineering and Environmental Services, LLC www.ae2s.com

SHEET TITLE: SITE LAYOUT OPTION 3			
CLIENT: CITY OF HILL CITY HILL CITY, SD		PREPARED BY: JJF CHECKED BY: XXX APPROVED BY: XXX	
PROJECT NO: 12021-2023-005 DATE: JUNE 2025 ALT. PROJECT NO: —	SHEET DESIGNATOR: EX	SHEET NO: 3	



Certification of Individual Project Design Disciplines Are Included On Their Individual Drawings, Respectively



0 40
Scale in Feet

- PRELIMINARY TREATMENT BUILDING
- CLARIFLOCCULATOR EXPANSION
- SBR
- PROPOSED ROAD SURFACE

SHEET TITLE: SITE LAYOUT OPTION 4

CLIENT: CITY OF HILL CITY HILL CITY, SD		PREPARED BY: JJF
PROJECT NO: 12021-2023-005		CHECKED BY: XXX
DATE: JUNE 2025		APPROVED BY: XXX
ALT. PROJECT NO: ---	EX	4

PROJECT TITLE: HILL CITY WWTFF IMPROVEMENTS		
STATUS: PRELIMINARY - NOT FOR CONSTRUCTION		
SYM	DATE	APPR



SUBSURFACE BORING LOG

AET JOB NO: P-0044392		LOG OF BORING NO. B-01 (p. 1 of 1)									
PROJECT: Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota											
SURFACE ELEVATION: 100.9		LATITUDE: 43.93356677			LONGITUDE: -103.55813161						
DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	BASE COURSE, 6-inches	GRAVEL SURFACING/ ALLUVIUM	16	M	SS	16					
2	LEAN CLAY with SAND, dark brown, very stiff (CL)										
3	LEAN CLAY, dark brown, firm (CL)		6	M	SS	15	15				
4											
5	SANDY LEAN CLAY, green-brown, firm to very stiff (CL)		7*	M	MC	15	15	95			
6											
7											
8											
9			5	M	SS	15	16				
10											
11											
12	SILTY SAND with GRAVEL, grey, medium dense (SM)		17*	M	MC	9					
13	CLAYEY SAND with GRAVEL, grey, medium dense (SC)		16	M	SS	10	8				
14											
15	SCHIST, iron oxidation staining present, black, very stiff		18*		MC	13					
16											
17		METAMORPHOSED TUFACEOUS SHALES									
18											
19											
20	SILTY SAND, schist lenses present, black, dense (SM)		40	W	SS	14			27	24	48
21											
22											
23											
24											
25	SCHIST, with silty sand lenses, black, hard		50/2		SS	NSR					
26											
27											
28											
29			50/3	W	SS	2					
30											
31											
32											
33			50/1		SS	NSR					
34											
35											
36											
Bottom of Boring											
*Note: The N-values shown for the Modified California samples have not been corrected for sampler size.											

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
35.0	3.25" HSA	7/17/25	9:30	15.0	15.0	--	--	15.0	
		7/17/25	13:30	35.0	--	31.0	--	16.0	
BORING COMPLETED: 7/17/25									
DR: SZ LG: WTL Rlg: 106									

AET_CORP-W-LAT-LONG P-0044392.GPJ AET+CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: **P-0044392** LOG OF BORING NO. **B-02 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **98.3** LATITUDE: **43.93371008** LONGITUDE: **-103.55777341**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	BASE COURSE , 4-inches	GRAVEL SURFACING/ ALLUVIUM	2	M	SS	6					
2	LEAN CLAY with SAND , dark brown, soft to firm (CL)										
3	gravel present below 2.5 feet		5	M	SS	6	16				
4											
5	CLAYEY SAND , with schist fragments, grey, loose to very loose		10*	M	MC	11					
6											
7											
8			4	M	SS	NSR					
9											
10	LEAN CLAY with SAND , green-brown, firm (CL)		7*	M	MC	16					
11											
12											
13	SANDY LEAN CLAY , grey, very soft to stiff (CL)		1	W	SS	11	26				
14											
15											
16			10*	W	MC	7	25	98			
17		SCHIST , with clayey sand lenses, grey, very dense									
18											
19											
20											
21		METAMORPHOSED TUFACEOUS SHALE	50/4	W	SS	7					
22											
23											
24											
25	CLAYEY SAND , with schist lenses, grey, very dense (SC)		50/4	W	SS	5					
26											
27											
28											
29											
30											
31			72/3	W	SS	14					
32											
	POORLY GRADED SAND , grey, very dense (SP)										
	Bottom of Boring- Auger Refusal at 32.5 feet *Note: The N-values shown for the Modified California samples have not been corrected for sampler size.										

DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
31.0	3.25" HSA	7/17/25	12:15	20.0	20.0	--	--	20.0	
		7/21/25	14:45	30.0	--	14.4	--	12.8	
BORING COMPLETED: 7/17/25									
DR: SZ LG: WTL Rig: 106									

AET_CORP-W-LAT-LONG P-0044392.GPJ AET-CPT-WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: **P-0044392** LOG OF BORING NO. **B-03 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **98.3** LATITUDE: **43.93385747** LONGITUDE: **-103.55755442**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	BASE COURSE, 6-inches	GRAVEL SURFACING ALLUVIUM	17	M	SS	16					
2	LEAN CLAY with SAND , dark brown to dark brownish-black, very stiff to very soft, trace schist fragments present (CL)										
3			8	M	SS	16	20				
4											
5											
6			17*	M	MC	17					
7											
8	very soft, dark brownish-black to brown below 7.5 feet		WH	M	SS	18	22				
9											
10			WH	M	MC	13	23	98			
11											
12											
13	SANDY LEAN CLAY , grey, very soft (CL)	METAMORPHOSED TUFFACEOUS SHALES	WH	W	SS	18	29				
14											
15	CLAYEY SAND , with sand lenses, black and grey, medium dense (SC)		13*	W	MC	18					
16											
17											
18											
19											
20	SILTY, CLAYEY SAND , with schist lenses, brownish-black, very dense (SC-SM)		53	W	SS	11			18	13	18
21											
Bottom of Boring											
*Note: The N-values shown for the Modified California samples have not been corrected for sampler size.											
DEPTH: DRILLING METHOD		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG		
20.0	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL			
		7/18/25	13:30	20.0	20.0	--	--	18.5			
		7/18/25	13:45	20.0	--	--	--	12.8			
BORING COMPLETED: 7/18/25											
DR: SZ LG: KK Rig: 106											

AET CORP W-LAT-LONG P-0044392.GPJ AET+CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: **P-0044392** LOG OF BORING NO. **B-04 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **98.8** LATITUDE: **43.93391072** LONGITUDE: **-103.55731616**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	CONCRETE, 4.5-inches	PAVEMENT	18	M	SS	13					
2	BASE COURSE, 6-inches	ALLUVIUM									
3	LEAN CLAY with SAND and GRAVEL, brown to brown and grey, very stiff to hard (CL) no gravel, with schist fragments below 2.5 feet		32	M	SS	15	7				
4											
5	SANDY SILT, with schist fragments, brown, very stiff (ML)		22*	M	MC	13					
6											
7											
8	SILTY LEAN CLAY, brown, soft (CL-ML)		4	M	SS	16	20		26	19	90
9											
10											
11			4*	M	MC	18					
12											
13	CLAYEY SAND, with schist lenses, black-brown, dense to medium dense (SC)	METAMORPHOSED TUFACEOUS SHALE	31	M	SS	18	6				
14											
15											
16			23*		MC	10					
17											
18											
19											
20	very dense below 20 feet										
21			43	W	SS	11					
Bottom of Boring- Auger Refusal at 21.5 feet											
*Note: The N-values shown for the Modified California samples have not been corrected for sampler size.											

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG	
20.0	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL		
		7/21/25	13:30	20.0	20.0	--	--	15.0		
		7/21/25	13:50	23.0	--	--	--	16.0		
BORING COMPLETED: 7/21/25										
DR: SZ LG: WTL Rig: 106										

AET CORP W-LAT-LONG P-0044392.GPJ AET-CPT-WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: P-0044392		LOG OF BORING NO. B-05 (p. 1 of 1)							
PROJECT: Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota									
SURFACE ELEVATION: 97.8		LATITUDE: 43.93358852		LONGITUDE: -103.55730381					

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	LEAN CLAY with SAND , dark brown, very stiff, trace organics present (CL)	ALLUVIUM	16	M	SS	11					
2											
3	LEAN CLAY with SAND , dark brown, very stiff (CL)	ALLUVIUM	19	M	SS	16	6				
4											
5	LEAN CLAY with SAND , with schist fragments, brown to dark brown, stiff to soft (CL)	ALLUVIUM	14*	M	MC	13	19				
6											
7	no schist below 7.5 feet	ALLUVIUM	7	M	SS	18					
8											
9		ALLUVIUM	4*	M	MC	12	23	96			
10											
11		ALLUVIUM	25	W	SS	14	27				
12											
13	SILTY SAND with GRAVEL , brown, medium dense (SM)	ALLUVIUM		W	SS						
14											
15	POORLY GRADED SAND , with schist fragments, brown, medium dense to very dense (SP)	METAMORPHOSED TUFFACEOUS SHALE	24*	W	MC	15					
16											
17		METAMORPHOSED TUFFACEOUS SHALE									
18											
19		METAMORPHOSED TUFFACEOUS SHALE	75/9	W	SS	12					
20											
21	No Sample Received at 22 feet	METAMORPHOSED TUFFACEOUS SHALE	50/0		SS	NSR					
22											
23	Bottom of Boring- Auger Refusal at 23.5 feet										

*Note: The N-values shown for the Modified California samples have not been corrected for sampler size.

DEPTH: 22.0 DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		7/21/25	9:10	15.0	15.0	--	--	15.0	
		7/21/25	9:55	22.0	22.0	--	--	13.0	
BORING COMPLETED: 7/21/25									
DR: SZ LG: KK Rig: 106									

AET CORP W-LAT-LONG P-0044392.GPJ AET-CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: P-0044392		LOG OF BORING NO. B-06 (p. 1 of 1)							
PROJECT: Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota									
SURFACE ELEVATION: 97.4		LATITUDE: 43.93377489		LONGITUDE: -103.55713904					

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL , 1-inch	TOPSOIL ALLUVIUM	13	M	SS	15					
2	LEAN CLAY with GRAVEL , dark brown, stiff (CL)										
3	SANDY SILT , with schist fragments, brown, firm to stiff (ML)		7	M	SS	10	11				
4											
5											
6			11*	M	MC	18					
7											
8	SILTY LEAN CLAY , dark brown, soft (CL-ML)										
9			4	M	SS	18	21		25	19	86
10											
11											
12			4*	M	MC	18					
13	SANDY SILT , dark brownish-black, very stiff (ML)										
14											
15	POORLY GRADED GRAVEL with SAND , brown, dense (GP)		38*	W	MC	12					
16	POORLY GRADED SAND , brown, dense to very dense (SP)										
17											
18		METAMORPHOSED TUFFACEOUS SHALE									
19											
20	with gravel below 20 feet		50/.2	W	SS	5					
21											
22											
23	no gravel below 23 feet		50/.2	W	SS	3					
24											
Bottom of Boring- Auger Refusal at 24.5 feet											
*Note: The N-values shown for the Modified California samples have not been corrected for sampler size.											

DEPTH: 23.0 DRILLING METHOD: 3.25" HSA		WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		7/21/25	11	15.0	15.0	--	--	14.0	
		7/21/25	12	24.5	--	--	--	13.0	
BORING COMPLETED: 7/21/25									
DR: SZ LG: KK Rig: 106									

AET_CORP W-LAT-LONG P-0044392.GPJ AET-CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: **P-0044392** LOG OF BORING NO. **B-08 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **101.3** LATITUDE: **43.93297187** LONGITUDE: **-103.55706240**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL , 1-inch LEAN CLAY with SAND , dark brown, firm to stiff (CL)	TOPSOIL ALLUVIUM	8	M	SS	14					
2											
3	with sand laminations, brown and dark brown below 2.5 feet		11	M	SS	16	15				
4											
5											
6			11	M	SS	18	16				
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
5.0	3.25" HSA	7/18/25	10:45	6.5	5.0	--	--	None	
BORING COMPLETED: 7/18/25									
DR: SZ LG: KK Rig: 106									

AET_CORP W-LAT-LONG P-0044392.GPJ AET-CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: **P-0044392** LOG OF BORING NO. **B-09 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **98.8** LATITUDE: **43.93328196** LONGITUDE: **-103.55616770**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL , 1-inch LEAN CLAY with SAND , dark brown, firm to stiff (CL)	TOPSOIL ALLUVIUM	8	M	SS	18					
2											
3			10	M	SS	17	14				
4											
5	SILT , dark brown, soft (ML)										
6			4	M	SS	16	19				
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
5.0	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		7/18/25	11:50	6.5	5.0	--	--	None	
BORING COMPLETED: 7/18/25									
DR: SZ LG: KK Rig: 106									

AET_CORP W-LAT-LONG P-0044392.GPJ AET-CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

AET JOB NO: **P-0044392** LOG OF BORING NO. **B-10 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **97.6** LATITUDE: **43.93383869** LONGITUDE: **-103.55660624**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL, 2-inches LEAN CLAY with SAND, dark brown to brown, firm (CL)	TOPSOIL ALLUVIUM	6	M	SS	17					
2											
3			5	M	SS	18	15				
4											
5											
6			5	M	SS	18	19				
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
5.0	3.25" HSA	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
		7/18/25	12:20	6.5	5.0	--	--	None	
BORING COMPLETED: 7/18/25									
DR: SZ LG: KK Rig: 106									

AET_CORP W-LAT-LONG P-0044392.GPJ AET+CPT+WELL.GDT 8/13/25



SUBSURFACE BORING LOG

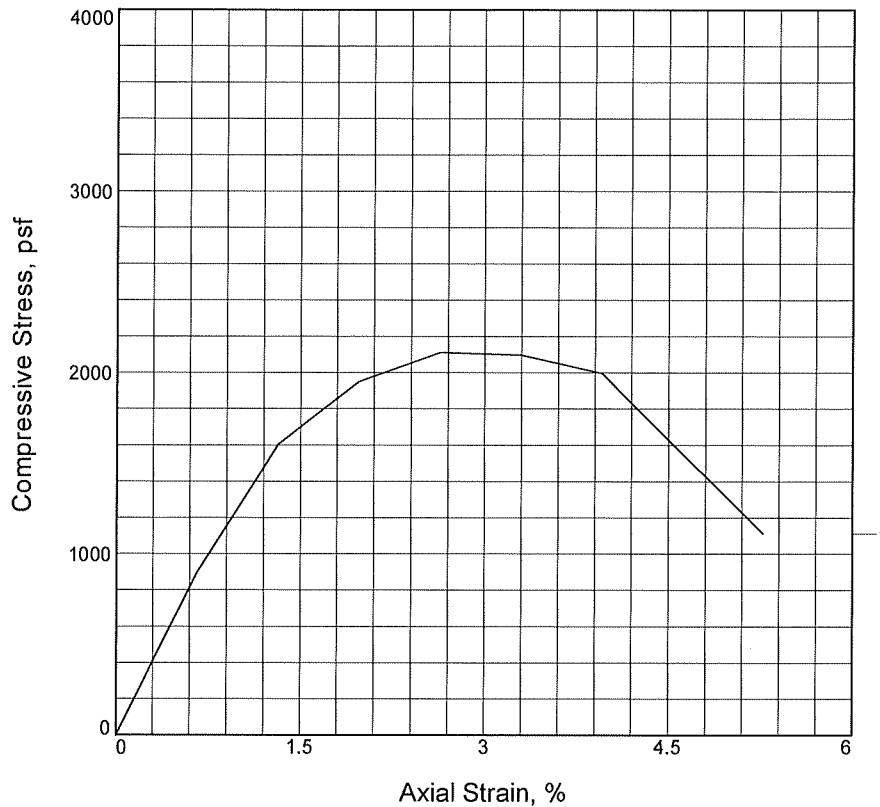
AET JOB NO: **P-0044392** LOG OF BORING NO. **B-11 (p. 1 of 1)**
 PROJECT: **Proposed Hill City Wastewater Treatment Facility Improvements; Hill City, South Dakota**
 SURFACE ELEVATION: **98.0** LATITUDE: **43.93332479** LONGITUDE: **-103.55762545**

DEPTH IN FEET	MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS				
							WC	DEN	LL	PL	%-#200
1	TOPSOIL , 2-inches LEAN CLAY with SAND , dark brown, firm to very stiff, trace organics and gravel present (CL)	TOPSOIL ALLUVIUM	7	M	SS	14					
2											
3	no organics, with schist fragments below 3 feet		20	M	SS	15	6				
4											
5											
6	SILT with SAND , with schist fragments, grey to brown, hard (ML)		38	M	SS	12	8				
	Bottom of Boring										

DEPTH:	DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
		DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
5.0	3.25" HSA	7/18/25	10:05	6.5	5.0	--	--	None	
BORING COMPLETED: 7/18/25									
DR: SZ LG: KK Rig: 106									

AET_CORP-WJAT-LONG P-0044392.GPJ AET-CPT+WELL.GDT 8/13/25

UNCONFINED COMPRESSION TEST



Sample No.	1		
Unconfined strength, psf	2112		
Undrained shear strength, psf	1056		
Failure strain, %	2.6		
Strain rate, in./min.	0.050		
Water content, %	15.1		
Wet density, pcf	109.4		
Dry density, pcf	95.1		
Saturation, %	54.0		
Void ratio	0.7404		
Specimen diameter, in.	1.92		
Specimen height, in.	3.79		
Height/diameter ratio	1.97		

Description: Sandy Lean Clay (CL)

LL =	PL =	PI =	Assumed GS= 2.65	Type: Modified California
------	------	------	------------------	---------------------------

Project No.: P-0044392

Date Sampled: 7/17/25

Remarks:

Client: City Of Hill City

Project: Proposed Hill City Wastewater Treatment Facility (WWTF) Improvements

Location: B-1

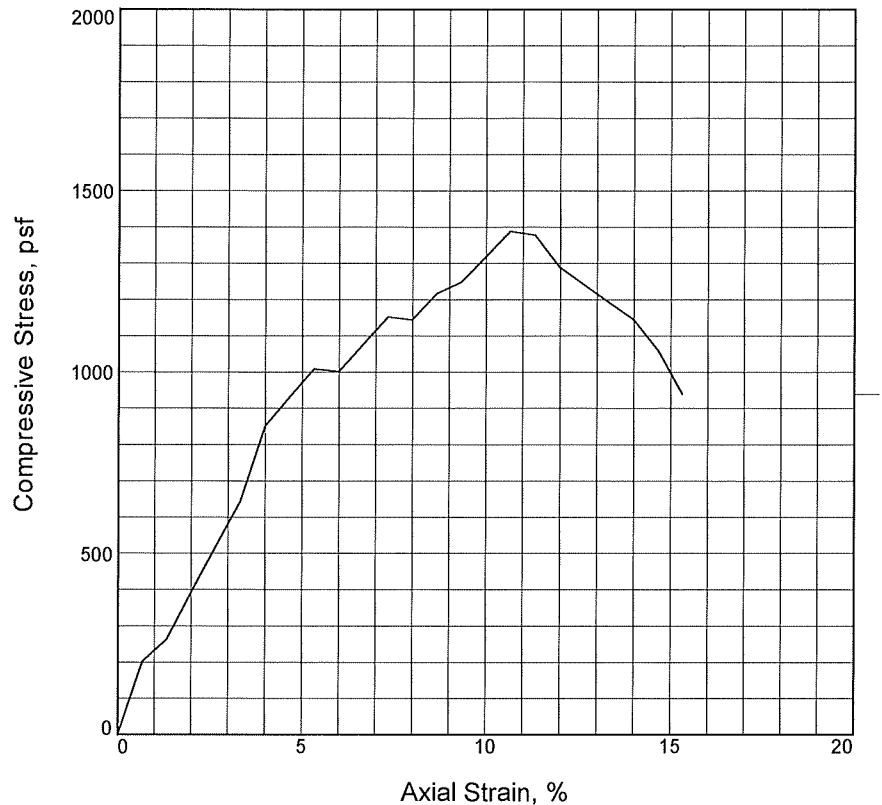
Sample Number: 3 **Depth:** 5

UNCONFINED COMPRESSION TEST
American Engineering Testing, Inc.
Rapid City, SD

Figure _____

Tested By: SP **Checked By:** WTL

UNCONFINED COMPRESSION TEST



Sample No.	1			
Unconfined strength, psf	1388			
Undrained shear strength, psf	694			
Failure strain, %	10.7			
Strain rate, in./min.	0.050			
Water content, %	22.5			
Wet density, pcf	119.9			
Dry density, pcf	97.9			
Saturation, %	86.3			
Void ratio	0.6892			
Specimen diameter, in.	1.94			
Specimen height, in.	3.76			
Height/diameter ratio	1.93			

Description: Lean Clay with Sand (CL)

LL =	PL =	PI =	Assumed GS= 2.65	Type: Modified California
------	------	------	------------------	---------------------------

Project No.: P-0044392

Date Sampled: 7/18/25

Remarks:

Client: City Of Hill City

Project: Proposed Hill City Wastewater Treatment Facility (WWTF) Improvements

Location: B-3

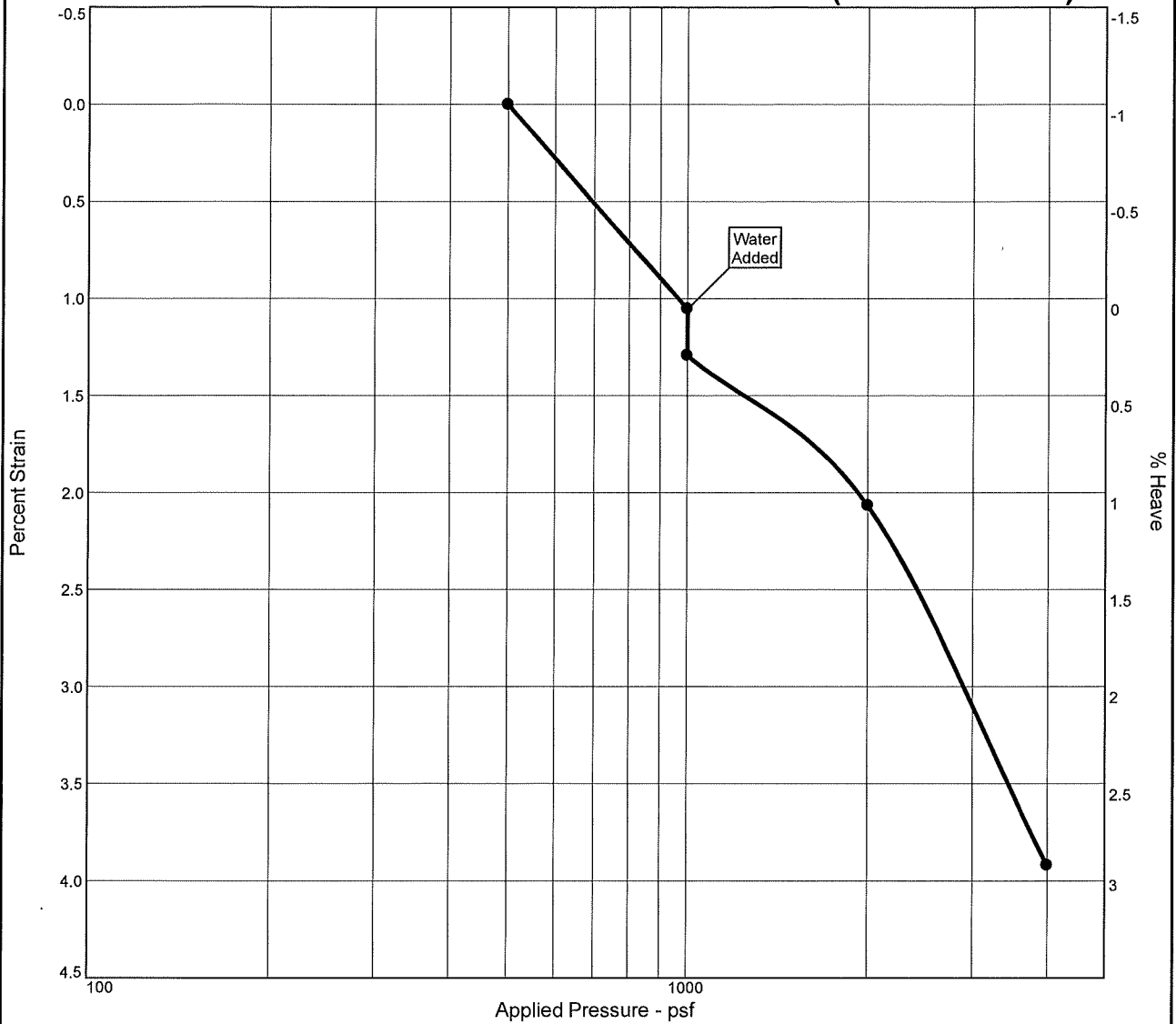
Sample Number: 5 **Depth:** 10

UNCONFINED COMPRESSION TEST
American Engineering Testing, Inc.
Rapid City, SD

Figure _____

Tested By: SP **Checked By:** WTL

SWELL-CONSOLIDATION TEST REPORT (ASTM D2435)



Natural		Dry Dens. (pcf)	LL	PI	Sp. Gr.	Overburden (psf)	P _c (psf)	C _c	C _r	Swell Press. (psf)	Heave %	e _o
Sat.	Moist.											
96.1 %	25.0 %	97.9			2.65	1800	1955	0.11			-0.2	0.690

MATERIAL DESCRIPTION	USCS	AASHTO
Sandy Lean Clay (CL)	CL	

Project No. P-0044392 **Client:** City Of Hill City
Project: Proposed Hill City Wastewater Treatment Facility (WWTF) Improvements

Location: B-2	Depth: 15	Sample Number: 7
----------------------	------------------	-------------------------

American Engineering Testing, Inc.

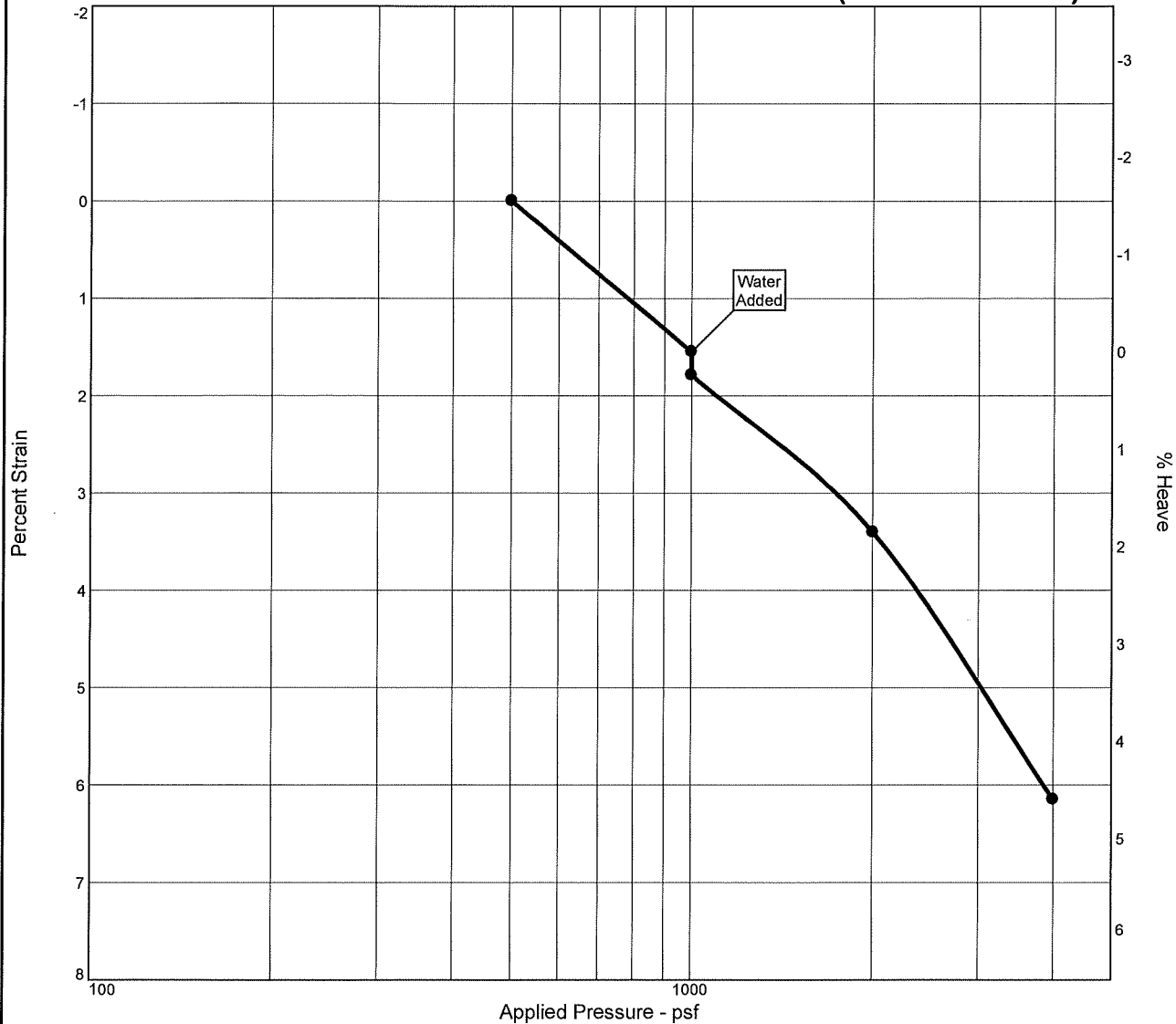
Rapid City, SD

Remarks:

Figure

Tested By: SP Checked By: WTL

SWELL-CONSOLIDATION TEST REPORT (ASTM D2435)



Natural	Dry Dens.	LL	PI	Sp. Gr.	Overburden	P _c	C _c	C _r	Swell Press.	Heave	e ₀
Sat.	Moist.	(pcf)			(psf)	(psf)			(psf)	%	
83.4 %	22.9 %	95.7		2.65	1200	2081	0.17			-0.2	0.728

MATERIAL DESCRIPTION	USCS	AASHTO
Lean Clay with Sand (CL)	CL	

Project No. P-0044392 Client: City Of Hill City Project: Proposed Hill City Wastewater Treatment Facility (WWTF) Improvements Location: B-5 Depth: 10 Sample Number: 5 American Engineering Testing, Inc. Rapid City, SD	Remarks: Figure
--	--

Tested By: SP _____ Checked By: WTL _____



American Engineering Testing, Inc.
Rapid City
1745 Samco Road
Rapid City, SD 57702
(605) 388-0029
www.teamAET.com

Proctor Report

Report No: PTR:AET-231291-S2

Issue No: 2

Client: Hill City, City Of

CC:

Project: Proposed Hill City WWTF Improvements

Hill City SD

Job No: P-0044392

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Wyatt Leadens

Date of Issue:

8/12/2025

Reviewed By:

Wyatt Leadens, EIT
Engineer II

Sample Details

Sample ID: AET-231291-S2

Date Sampled: 7/21/2025

Sampling Method: Soil Boring

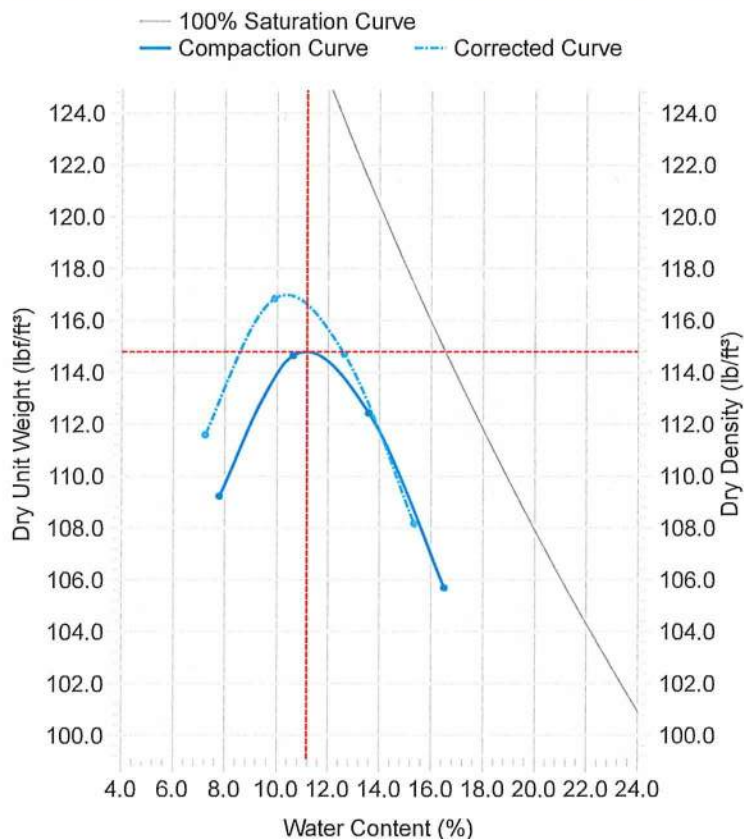
Material: Lean Clay with Sand, brown (CL)

Location: Boring B-5

Depth: 1'-5'

Sampled By: Kally Knutson

Dry Unit Weight - Water Content Relationship



Test Results

ASTM D698

Std. Maximum Dry Unit Weight (lb/ft³): 114.8

Std. Optimum Water Content (%): 11.2

Retained on 3/4" Sieve (%): 1

Passing 3/4" Sieve (%): 99

Cumulative Retained on 3/8" Sieve (%): 3

Retained on 3/8" Sieve (%): 2

Passing 3/8" Sieve (%): 97

Cumulative Retained on No.4 Sieve (%): 7

Retained on No.4 Sieve (%): 4

Passing No.4 Sieve (%): 93

Method: A

Preparation Method: Moist

Test Portion Specific Gravity: 2.65

Determined By: Estimated

Tested By: Christine Olson

Date Tested: 7/31/2025

ASTM D4718

Corrected Maximum Dry Unit Weight (lb/ft³): 117.0

Corrected Optimum Water Content (%): 10.4

Oversize Specific Gravity: 2.50

Oversize Particles (%): 7

Comments



American Engineering Testing, Inc.
Rapid City
1745 Samco Road
Rapid City, SD 57702
(605) 388-0029
www.teamAET.com

Proctor Report

Report No: PTR:AET-231291-S1

Issue No: 1

Client: Hill City, City Of

CC:

Project: Proposed Hill City WWTF Improvements

Hill City SD

Job No: P-0044392

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Kally Knutson

Date of Issue:

8/5/2025

Reviewed By:

Kally Knutson
Geologist I

Sample Details

Sample ID: AET-231291-S1

Date Sampled: 7/18/2025

Sampling Method: Soil Boring

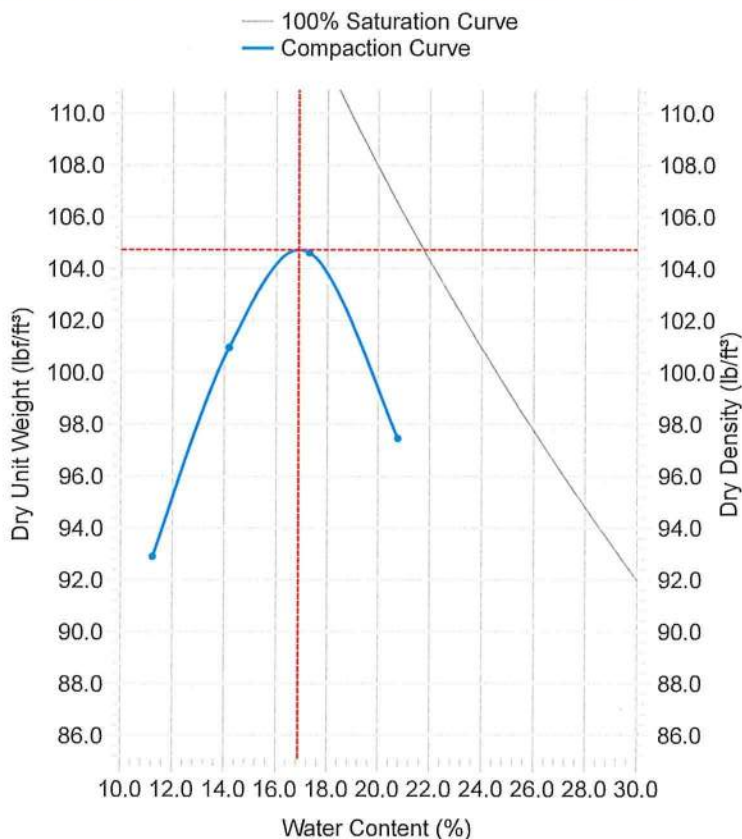
Material: Lean Clay with Sand, dark brown (CL)

Location: Boring B-8

Depth: 1'-5'

Sampled By: Kally Knutson

Dry Unit Weight - Water Content Relationship



Test Results

ASTM D698

Std. Maximum Dry Unit Weight (lb/ft³): 104.7

Std. Optimum Water Content (%): 16.9

Retained on 3/8" Sieve (%): 0

Passing 3/8" Sieve (%): 100

Cumulative Retained on No.4 Sieve (%): 0

Retained on No.4 Sieve (%): 0

Passing No.4 Sieve (%): 100

Method: A

Preparation Method: Moist

Test Portion Specific Gravity: 2.65

Determined By: Estimated

Tested By: Christine Olson

Date Tested: 7/31/2025

Comments



American Engineering Testing, Inc.
Rapid City
1745 Samco Road
Rapid City, SD 57702
(605) 388-0029
www.teamAET.com

California Bearing Ratio Test Report

Report No: CBR:AET-231291-S1

Issue No: 1

Client: Hill City, City Of

CC:

Project: Proposed Hill City WWTF Improvements

Hill City SD

Job No: P-0044392

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Kally Knutson

Date of Issue:

8/6/2025

Reviewed By:

Kally Knutson
Geologist I

Sample Details

Sample ID: AET-231291-S1

Date Sampled: 7/18/2025

Sampled By: Kally Knutson

Sampling Method: Soil Boring

Source:

Material: Lean Clay with Sand, dark brown (CL)

Specification:

Location: Boring B-8

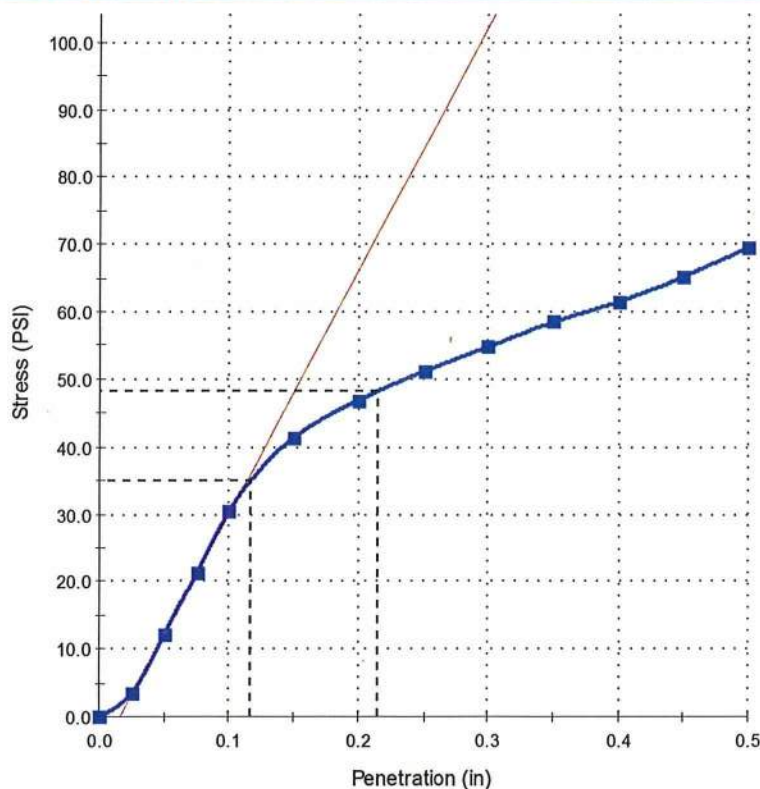
Tested By: Sage Preble

Date Tested: 8/5/2025

CBR At 0.1in (%): 3.5

CBR At 0.2in (%): 3.2

Stress vs Penetration



Test Results

ASTM D 1883

CBR At 0.1in (%): 3.5
CBR At 0.2in (%): 3.2
Compactive Effort: ASTM D 698
Number of Blows: 25
% of Maximum Dry Density: 94.9
Dry Density Before Soaking (lb/ft³): 99.3
MC Before Compaction (%): 17.0
MC After Compaction (%): 17.0
Moisture Content of Top 1in (%): 24.7
Average Moisture Content (%): 22.5
Maximum Dry Density (lb/ft³): 104.7
Optimum Moisture Content (%): 16.9
Sample Condition: Soaked
Immersion Period (h): 96
Swell (%): 1.4
Surcharge Mass (lb): 10.00
Date Tested: 8/5/2025

Comments



MIDCONTINENT
TESTING LABORATORIES, INC.

2381 South Plaza Drive P.O. Box 3388 Rapid City, SD 57709
(605) 348-0111 -- www.thechemistrylab.com

Sample Site: Pond Bottom 1
Project Name: Hill City WWTF Improvements
Project Number: P-0044392
Sampled: 07/18/25 at 02:08 PM
by Kally Knutson
Sample Matrix: Soil

Lab ID#: 20250722581
Received: 07/21/25 at 12:00 PM
by Josh Bucknall
Account: W1202 - AET - Rapid City

AET
1745 SAMCO ROAD
RAPID CITY, SD 57702

Parameter	Result	Units	DF	Method	Analyst/Date
-----------	--------	-------	----	--------	--------------

Notes:

PCBs analyzed by Energy Labs. See attached report.

Report Approved By:

Report Approved On: 8/14/2025 4:21:24 PM



2381 South Plaza Drive P.O. Box 3388 Rapid City, SD 57709
(605) 348-0111 -- www.thechemistrylab.com

Sample Site: Pond Bottom 2
Project Name: Hill City WWTF Improvements
Project Number: P-0044392
Sampled: 07/18/25 at 02:11 PM
by Kally Knutson
Sample Matrix: Soil

AET
1745 SAMCO ROAD
RAPID CITY, SD 57702

Lab ID#: 20250722582
Received: 07/21/25 at 12:00 PM
by Josh Bucknall
Account: W1202 - AET - Rapid City

Parameter	Result	Units	DF	Method	Analyst/Date
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Notes:

PCBs analyzed by Energy Labs. See attached report.

Report Approved By:

Report Approved On: 8/14/2025 4:21:24 PM



2381 South Plaza Drive P.O. Box 3388 Rapid City, SD 57709
(605) 348-0111 -- www.thechemistrylab.com

Sample Site: Pond Bottom 3
Project Name: Hill City WWTF Improvements
Project Number: P-0044392
Sampled: 07/18/25 at 02:15 PM
by Kally Knutson
Sample Matrix: Soil

Lab ID#: 20250722583
Received: 07/21/25 at 12:00 PM
by Josh Bucknall
Account: W1202 - AET - Rapid City

AET
1745 SAMCO ROAD
RAPID CITY, SD 57702

Parameter	Result	Units	DF	Method	Analyst/Date
-----------	--------	-------	----	--------	--------------

Notes:

PCBs analyzed by Energy Labs. See attached report.

Report Approved By:

Report Approved On: 8/14/2025 4:21:24 PM



MIDCONTINENT

TESTING LABORATORIES, INC.

Page 1

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(605) 348-0111 -- www.thechemistrylab.com

Lab Numbers: 20250722581 - 20250722583

QC Sample Report

Parameter	Lab#	QC Value	Smp Value	Spike	DF	Result	Limits	Method
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Approved By: 

Approved On: 08/14/2025 04:21 PM



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(605) 348-0111 • www.TheChemistryLab.com

CHAIN OF CUSTODY RECORD

Company	American Engineering Testing
Project Name/ Mgr.	Hill City WWTf Improvements/ Wyatt Leadens
Project Number	P-0044392
Sampled by	Kelly Mouton
Sampled by	Kelly Kautson

PRESERVED WITH	
FILTERED (GFI)	
REFRIGERATED (VIN)	
ANALYSES REQUESTED	PCB

FOR LAB USE ONLY	
Seal Intact (Y/N) Number	Y
Sample Condition	
Temperature of Container	23.3°C

REQUESTED TURN AROUND	
STANDARD	RUSH

	SAMPLE NAME	DATE	TIME	MATRIX	NO. OF CONTAINERS	COMMENTS	LAB #
1	Pond Bottom 1	7/18/25	14:08		2		581
2							
3							
4	Pond Bottom 2	7/18/25	14:11		2		582
5							
6							
7	Pond Bottom 3	7/18/25	14:15		2		583
8							
9							
10							
11							
12							

RELINQUISHED BY (Signature)	COMPANY NAME	DATE	TIME	RECEIVED BY (Signature)	COMPANY NAME	DATE	TIME
Wyatt Leadens	AET	7/21/25	12:00	Jr. Run	met	7/21/25	12:00



SAMPLE RECEIPT CHECKLIST

Company Name AET Date/Time Received 7/21/25 1200
Project Hill City WWTF Improvements Received by Joan
Lab Number(s) 20250722 581-583 Carrier Name Hand Delivered

Yes No

UNPACKING

Initials

- ☒ ☐ 1. Shipping container in good condition? _____
- ☐ ☒ 2. Custody seals present on shipping container?
Condition: Intact ☐ Broken ☐ _____
- ☒ ☐ 3. Ice / Blue Ice (circle one) present in shipping container?
Container(s) Temp. 1. 23.5°C 2. _____ 3. _____ 4. _____
- ☐ ☒ 4. Bottles broken and/or leaking? (Photograph broken bottles.) _____
- ☐ ☒ 5. Custody seals on sample bottles?
Condition: Intact ☐ Broken ☐ _____

Yes No

LABELING

Initials

- ☒ ☐ 6. Chain of custody Present? _____
- ☐ ☐ 7. Chain of custody includes signatures, dates, and times when relinquished and received? _____
- ☒ ☐ 8. Chain of custody agrees with bottle count? _____
- ☐ ☐ 9. Chain of custody agrees with labels? _____
- ☐ ☐ 10. Samples received within holding times? _____
- ☐ ☐ 11. Samples in proper container? _____
- ☒ ☐ 12. Sufficient sample volume for indicated tests? _____

PRESERVATIVE

Yes No

Initials

Yes No

Initials

- ☐ ☐ 13. Metals bottle(s) pH < 2? _____
- ☐ ☐ 14. Nutrient bottle(s) pH < 2? _____
- ☐ ☐ 15. Cyanide bottle(s) pH > 12? _____
- ☐ ☐ 16. Sulfide bottle(s) pH > 9? _____
- ☐ ☐ 17. TOC bottle(s) pH < 2? _____
- ☐ ☐ 18. Oil & Grease bottle(s) pH < 2? _____
- ☐ ☐ 19. Volatiles pH < 2? _____

COMMENTS: _____



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Gillette, WY 307.686.7175 • Helena, MT 406.442.0711

LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Client: Mid-Continent Testing Laboratories Inc
Project: Hill City WWTF Improvements
Lab ID: B25072160-001
Client Sample ID: 20250722581

Report Date: 08/14/25
Collection Date: 07/18/25 14:08
Date Received: 07/24/25
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture	16.4	wt%		0.2		D2974	08/07/25 06:50 / rik
POLYCHLORINATED BIPHENYLS (PCBS)							
Aroclor 1016	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1221	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1232	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1242	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1248	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1254	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1260	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1262	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Aroclor 1268	ND	mg/kg		0.013		SW8082A	07/28/25 20:02 / cjh
Surr: Decachlorobiphenyl	93.0	%REC		50-126		SW8082A	07/28/25 20:02 / cjh
Surr: Tetrachloro-m-xylene	69.0	%REC		42-115		SW8082A	07/28/25 20:02 / cjh

Report Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



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LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Client: Mid-Continent Testing Laboratories Inc
Project: Hill City WWTF Improvements
Lab ID: B25072160-002
Client Sample ID: 20250722582

Report Date: 08/14/26
Collection Date: 07/18/25 14:11
Date Received: 07/24/25
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture	69.7	wt%		0.2		D2974	08/07/25 06:52 / rik
POLYCHLORINATED BIPHENYLS (PCBS)							
Aroclor 1016	ND	mg/kg	D	0.033	SW8082A		07/28/25 20:21 / clh
Aroclor 1221	ND	mg/kg		0.013	SW8082A		07/28/25 20:21 / clh
Aroclor 1232	ND	mg/kg	D	0.066	SW8082A		07/28/25 20:21 / clh
Aroclor 1242	ND	mg/kg	D	0.050	SW8082A		07/28/25 20:21 / clh
Aroclor 1248	ND	mg/kg		0.013	SW8082A		07/28/25 20:21 / clh
Aroclor 1254	ND	mg/kg	D	0.050	SW8082A		07/28/25 20:21 / clh
Aroclor 1260	ND	mg/kg	D	0.050	SW8082A		07/28/25 20:21 / clh
Aroclor 1262	ND	mg/kg	D	0.050	SW8082A		07/28/25 20:21 / clh
Aroclor 1268	ND	mg/kg		0.013	SW8082A		07/28/25 20:21 / clh
Sum: Decachlorobiphenyl	84.0	%REC		50-126	SW8082A		07/28/25 20:21 / clh
Sum: Tetrachloro-m-xylene	75.0	%REC		42-115	SW8082A		07/28/25 20:21 / clh

Report Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit
D - Reporting Limit (RL) increased due to sample matrix

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



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LABORATORY ANALYTICAL REPORT

Prepared by Billings, MT Branch

Client: Mid-Continent Testing Laboratories Inc
Project: Hill City WWTF Improvements
Lab ID: B25072160-003
Client Sample ID: 2025072583

Report Date: 08/14/25
Collection Date: 07/18/25 14:15
Date Received: 07/24/25
Matrix: Solid

Analyses	Result	Units	Qualifiers	RL	MCL/ QCL	Method	Analysis Date / By
PHYSICAL CHARACTERISTICS							
Moisture	33.9	wt%		0.2		D2974	08/07/25 06:53 / rik
POLYCHLORINATED BIPHENYLS (PCBS)							
Aroclor 1016	ND	mg/kg		0.013	SW8082A		07/28/25 20:40 / clh
Aroclor 1221	ND	mg/kg		0.013	SW8082A		07/28/25 20:40 / clh
Aroclor 1232	ND	mg/kg	D	0.050	SW8082A		07/28/25 20:40 / clh
Aroclor 1242	ND	mg/kg	D	0.033	SW8082A		07/28/25 20:40 / clh
Aroclor 1248	ND	mg/kg	D	0.050	SW8082A		07/28/25 20:40 / clh
Aroclor 1254	ND	mg/kg	D	0.10	SW8082A		07/28/25 20:40 / clh
Aroclor 1260	ND	mg/kg	D	0.067	SW8082A		07/28/25 20:40 / clh
Aroclor 1262	ND	mg/kg	D	0.067	SW8082A		07/28/25 20:40 / clh
Aroclor 1268	ND	mg/kg		0.013	SW8082A		07/28/25 20:40 / clh
Sum: Decachlorobiphenyl	79.0	%REC		50-126	SW8082A		07/28/25 20:40 / clh
Sum: Tetrachloro-m-xylene	74.0	%REC		42-115	SW8082A		07/28/25 20:40 / clh

Report Definitions: RL - Analyte Reporting Limit
QCL - Quality Control Limit
D - Reporting Limit (RL) increased due to sample matrix

MCL - Maximum Contaminant Level
ND - Not detected at the Reporting Limit (RL)



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QA/QC Summary Report

Prepared by Billings, MT Branch

Work Order: B25072160

Report Date: 08/14/25

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: D2974										Batch: R447192
Lab ID: B25072160-003A DUP		Sample Duplicate					Run: BAL 101-F_250808A			08/07/25 07:02
Moisture		29.9	wt%	0.20				12	20	

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)



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QA/QC Summary Report

Prepared by Billings, MT Branch

Work Order: B25072160

Report Date: 08/14/25

Analyte	Count	Result	Units	RL	%REC	Low Limit	High Limit	RPD	RPDLimit	Qual
Method: SW8082A										Batch: 201861
Lab ID: AR2154-201861	4	Laboratory Control Sample			Run: LECD.I_250728B			07/28/25 19:25		
Aroclor 1221		0.265	mg/kg	0.013	82	38	116			
Aroclor 1254		0.306	mg/kg	0.013	95	62	126			
Surr: Decachlorobiphenyl				0.0017	93	50	126			
Surr: Tetrachloro-m-xylene				0.0017	62	42	115			
Lab ID: MB-201861	11	Method Blank			Run: LECD.I_250728B			07/28/25 19:44		
Aroclor 1016		ND	mg/kg	0.013						
Aroclor 1221		ND	mg/kg	0.013						
Aroclor 1232		ND	mg/kg	0.013						
Aroclor 1242		ND	mg/kg	0.013						
Aroclor 1248		ND	mg/kg	0.013						
Aroclor 1254		ND	mg/kg	0.013						
Aroclor 1260		ND	mg/kg	0.013						
Aroclor 1262		ND	mg/kg	0.013						
Aroclor 1268		ND	mg/kg	0.013						
Surr: Decachlorobiphenyl				0.0017	89	50	126			
Surr: Tetrachloro-m-xylene				0.0017	59	42	115			
Lab ID: B25072160-003AMB	4	Sample Matrix Spike			Run: LECD.I_250728B			07/28/25 20:59		
Aroclor 1221		0.297	mg/kg	0.013	89	38	116			
Aroclor 1254		0.343	mg/kg	0.10	103	62	126			D
Surr: Decachlorobiphenyl				0.0017	88	50	126			
Surr: Tetrachloro-m-xylene				0.0017	76	42	115			
Lab ID: B25072160-003ADB	4	Sample Matrix Spike Duplicate			Run: LECD.I_250728B			07/28/25 21:17		
Aroclor 1221		0.295	mg/kg	0.013	88	38	116	0.5	40	
Aroclor 1254		0.349	mg/kg	0.10	104	62	126	1.5	40	D
Surr: Decachlorobiphenyl				0.0017	87	50	126			
Surr: Tetrachloro-m-xylene				0.0017	79	42	115			

Qualifiers:

RL - Analyte Reporting Limit

ND - Not detected at the Reporting Limit (RL)

D - Reporting Limit (RL) Increased due to sample matrix

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B

Geotechnical Report Limitations and Guidelines for Use

AET Project No. P-0044392

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by GBA¹, of which we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Understand the Geotechnical Engineering Services Provided for this Report

Geotechnical engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical engineering services is typically a geotechnical engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

B.2.2 Geotechnical Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client.

Likewise, geotechnical engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. If you are the least bit uncertain about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

¹ Geoprosessional Business Association, 1300 Piccard Drive, LL14, Rockville, MD 20850
Telephone: 301/565-2733: www.geoprosessional.org, 2019

B.2.3 Read the Full Report

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. Read and refer to the report in full.

Appendix B

Geotechnical Report Limitations and Guidelines for Use

AET Project No. P-0044392

B.2.4 You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, always inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

B.2.5 Most of the “Findings” Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed. The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

B.2.6 This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations only after observing actual subsurface conditions exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.

B.2.7 This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

B.2.8 Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical engineering report, along with any attachments or appendices, with your contract documents, but be certain to note conspicuously that you've included the material for information purposes only. To avoid misunderstanding, you may also want to note that “informational purposes” means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, only from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to and be sure to allow enough time to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Appendix B

Geotechnical Report Limitations and Guidelines for Use

AET Project No. P-0044392

B.2.9 Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.10 Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical engineering study. For that reason, a geotechnical engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated subsurface environmental problems have led to project failures. If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

B.2.11 Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. Geotechnical engineers are not building-envelope or mold specialists.

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DIVISION 01 GENERAL REQUIREMENTS

SECTION 01 11 13
WORK COVERED BY CONTRACT DOCUMENTS

PART 1 - GENERAL

1.01 OVERVIEW

A. This section includes:

1. Project Description.
2. Project Work Covered by Contract Documents.
3. Contract Information.
4. Administrative and Procedural Sections.
5. Description of Work for All Construction.
6. Work by Owner.
7. Instrumentation and Control Responsibilities of CMAR and Work by Others.
8. Work Under Other Contracts.
9. Critical Work Sequences.
10. Access to Streets and Highways.
11. Field Engineering.
12. Reference Standards.
13. NPDES Construction Storm Water Permit.
14. Fines.
15. Coordination of Existing Conditions and Contract Documents.
16. Salvaged Demolition Debris.
17. Restocking.
18. Excavation Stockpiling

1.02 PROJECT DESCRIPTION

Contract No. 1 - Hill City WWTF Improvements

The Project generally consists of the following primary components:

1. Site Civil: Includes all work, materials, and equipment related to grading, drainage, site piping, utilities, roadways, paving, and site access.
2. Pretreatment Building (PTB): Includes the construction of a new pretreatment building complete with concrete channels influent channels, screening equipment, vortex grit removal, grit pumping, and flow equalization/distribution to downstream treatment processes. Portions of the building are located below existing grade.
3. Sequencing Batch Reactor (SBR) Treatment System: Construction of a new, below-grade SBR basin containing aeration diffuser, sludge pump, decant mechanism, mechanical mixers, and decant pumping from an

adjacent lift station. Some structural elements of SBR2 to be completed under Work Package No. 1.

4. Process Building Equipment Replacement: Demolition and replacement of equipment located in the existing process building including UV disinfection equipment and aeration piping. Also includes installation of a new process blower, fuzzy filter, effluent reuse pump, and all associated piping and valving.
5. Electrical Distribution Building (EB): Installation of a new electrical building and electrical gear including process controls, switch gear, back-up power, and all necessary conduit to supply power throughout the site.

1.03 PROJECT WORK COVERED BY CONTRACT DOCUMENTS

A. Work associated with the Project will be comprised of the following Contracts:

1. **Contract No. 1 – Hill City WWTF Improvements**

1.04 CONTRACT INFORMATION

- A. The Owner will award a single Prime Contract for which the Work will be completed under a lump sum contract for Contract No.1.
- B. The CMAR shall not commence work until proper execution of the contract and written authorization to proceed has been issued by the OWNER. Proper execution of the contract shall include all surety bonds and insurance requirements.
- C. The division of work as made by the specifications and contract drawings is for the purpose of specifying work which is required. There is no attempt to make classification according to trades or any agreements, which may exist between contractors or subcontractors and trade unions. Classification of the work shall be the CMAR'S responsibility.
- D. The location of work under these contract documents is located on property of the OWNER or easements obtained by the OWNER, as shown on the contract drawings.
- E. Completion Dates:
 1. Substantial Completion (Acceptance of Performance and Operation Testing results) 12/16/2027.
 2. Final Completion 01/15/2028.
- F. Liquidation Damages for this project are as indicated in the Standard Contract between OWNER and CMAR.
- G. Work of the Contract is identified in the following Articles.

1.05 ADMINISTRATIVE AND PROCEDURAL SECTIONS

- A. Division 00 – Procurement and Contracting Requirements: All Sections.
- B. Division 01 – General Requirements: All Sections.

1.06 DESCRIPTION OF WORK FOR ALL CONSTRUCTION

- A. General: The following is provided to assist the Bidder in locating the major components and Work associated with the various bid items. It is not intended to provide a list of every drawing or specification that describes work associated with each bid item. In addition to the work shown or specified in the Specifications and Drawings listed below, Bidder shall include all work related to each bid item in the bidder's price for each bid item including, but not limited to, Division 00, Division 01, Civil, Architectural, Structural, Process, Mechanical, and Electrical.
 - 1. Base Bid:
 - a. Specifications: All Divisions and Sections:
 - b. Drawings: All Drawings.

1.07 WORK BY OWNER

- A. CMAR shall coordinate the timing and operational requirements of the Work with the Owner and Engineer.
- B. Owner will provide control system programming for the Project. CMAR shall coordinate control system Work with Engineer and allow ample time for completion of required control system, check-out, programming, and start-up and training services to meet Contractor's Substantial and Final Completion dates.
- C. Decommissioning of process units, tanks, equipment or systems as required by the CMAR for the purposes of completing the Work. Decommissioning is limited to taking the unit, tank, item of equipment or system out of service. The CMAR is responsible for disconnecting piping, power, utilities, and controls; for demolition; for temporary valves, barriers, piping, barricades, and other temporary facilities; and all other Work.
- D. Isolation, initial liquid draining or removal of chemicals or solids, and hose cleaning of tanks and basins, unless otherwise specified. CMAR will provide sites for disposal of process liquids or slurries generated by isolation and flushing activities. After initial isolation, initial draining, removal of chemicals and solids, and hose cleaning, CMAR shall be responsible for additional washing or cleaning needed to complete the Work.
- E. For all piping systems, unless otherwise specified herein, the Owner will drain the lines and operate valves.

- F. Initial filling of process units, tanks, or systems for the purpose of testing except as otherwise specified.
- G. Filling of process units, tanks or systems for the purpose of placing them into service.
- H. Operation of existing facilities not taken out of service or otherwise made available to the CMAR for purposes of executing the Work.

1.08 WORK UNDER OTHER CONTRACTS

- A. The Owner may award additional contracts which may affect operation of the CMAR. The CMAR for this Project will be required to coordinate construction sequencing with other contracts.

1.09 CRITICAL WORK SEQUENCES

- A. Coordinate construction schedule and operations with Owner and Engineer to accommodate Owner occupancy requirements.
- B. Sequencing of the Work shall be the responsibility of the CMAR with input from all subcontractors.
- C. CMAR shall provide Owner and Engineer full access to existing facilities for the duration of the project.
- D. Portions of the Work have been identified as Critical Work Sequences to provide guidelines for the CMAR to keep the existing WWTF in continuous operation. CMAR shall provide temporary facilities and make temporary modifications as necessary to keep the existing facilities in operation during the construction period.

1.10 ACCESS TO STREETS AND HIGHWAYS

- A. Maintain suitable means of access for property owners abutting streets and highways involved in construction, except as specifically permitted otherwise by Owner.
- B. The CMAR shall be responsible for all construction signing, flagging, and protection of the public. Signing shall conform to requirements as set forth in the Manual on Uniform Traffic Control devices.
- C. Whenever construction is stopped due to inclement weather, weekends, holidays, or other reasons, suitable access shall be provided for all property owners.
- D. Maintain access for firefighting equipment and access to fire hydrants.

1.11 FIELD ENGINEERING

- A. Provide field engineering services; establish grades, lines, and levels, by use of recognized engineering survey practices, as required.
- B. Engineer shall provide control data points one (1) time at start of construction. Utility construction staking shall be responsibility of CMAR.

1.12 REFERENCE STANDARDS

- A. For products specified by association or trade standards, comply with requirements of the standard, except when requirements that are more rigid are specified or are required by applicable codes.
- B. The date of the standard is that in effect as of the bid date, or date of Owner-CMAR Agreement when there are no bids, except when a specific date is specified.
- C. Obtain copies of standards when required by contract documents. Maintain copy at job site during progress of the specific Work.

1.13 NPDES CONSTRUCTION STORM WATER PERMIT

- A. The Project consists of disturbing more than one (1) acre of area and will require an NPDES/SDS Construction Storm Water Permit.
- B. Following award of the contract the Owner will prepare the NPDES/SDS Construction Storm-water Permit Application for the Project to be signed and submitted jointly by the Owner and CMAR.
- C. CMAR shall be responsible for all provisions required in the NPDES Construction Storm Water Permit for the Project including the storm water pollution prevention plan (SWPPP) that is required to be submitted with the permit and all comments received by the South Dakota Department of Agriculture and Natural Resources (DANR) regarding the permit and SWPPP for approval.

1.14 FINES

- A. In the event the OWNER is fined by the South Dakota Department of Agriculture and Natural Resources, Environmental Protection Agency or or other Agency as a result of the CMAR'S actions or lack of actions, the OWNER will deduct from payment, due the CMAR, corresponding amounts to cover the cost of such fines, including the costs of related engineering and legal fees.

1.15 COORDINATION OF EXISTING CONDITIONS AND CONTRACT DOCUMENTS

- A. Data on subsurface conditions are made available for convenience of CMAR and are not intended as representations or warranties of accuracy or continuity between soil borings.

- B. It is expressly understood that the OWNER will not be responsible for interpretations or conclusions drawn by CMAR from subsurface data. Additional subsurface data gathering operations may be made by CMAR. Contact OWNER for site access for additional test borings and/or other exploratory operations which may be made by CMAR at no cost to OWNER.
- C. Locate existing underground utilities in areas of work. Provide adequate means of support and protection during operations for utilities that are to remain in place.
- D. The locations of the utilities shown on the Drawings cannot be guaranteed. CMAR shall determine exact location of utilities. Should uncharted or incorrectly charted piping or other utilities be encountered, consult utility owner immediately for directions. Cooperate with OWNER and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
- E. Do not interrupt existing utilities except when permitted in writing by ENGINEER and then only after acceptable temporary utility services have been provided.
- F. Take and verify dimensions of existing structures, piping, and equipment required for the proper fabrication and installation of new piping and equipment.
- G. The Drawings indicate required pipe sizes and the general arrangement for major piping and equipment. Layout and arrangement for certain other piping systems shall be in conformance to the equipment items furnished. Locations shall be verified in the field by the CMAR. Valves and fittings furnished shall be of such dimensions to allow for the installation of this piping as shown on the Drawings. In the event it should become necessary to change the location of the work due to interference with other work, the CMAR shall request written permission from the ENGINEER before making changes, and such changes shall be made without added cost to OWNER. Under no circumstances shall the pipe sizes indicated on the Drawings be changed without first having the written approval of the ENGINEER.
- H. The final length and location of required pipe connections to equipment shall be coordinated to meet the requirements and recommendations of the equipment manufacturer and shall be subject to the approval of the ENGINEER.
- I. Install no work that directly connects to equipment until such time as complete shop drawings of said equipment have been reviewed and approved by the ENGINEER.
- J. Discrepancies discovered before or after work has started shall be brought to the attention of the ENGINEER immediately, and the ENGINEER reserves the right to require minor changes in the work of CMAR to eliminate such discrepancies.

1.16 SALVAGED DEMOLITION DEBRIS

- A. OWNER shall have the right to retain select demolition debris. At the discretion of OWNER, select demolition debris items shall be stored on-site and remain the property of the OWNER. OWNER shall designate the location for storage of salvageable demolition debris items. CMAR shall place selected items in designated storage area.

1.17 RESTOCKING

- A. There will be no additional compensation made to CMAR due to restocking charges for materials not used on the project.

1.18 EXCAVATION STOCKPILING

- A. All excess excavated material on WWTF site shall be disposed of by CMAR. Storage of excavated material shall be coordinated by the CMAR as the construction site has limited storage space.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 11 13

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SECTION 01 11 16
WORK BY OWNER

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Work By Owner.

1.02 WORK BY OWNER

- A. Engineer shall provide reference points for the Project one time.
 - 1. Establish Site benchmarks once for use by CMAR as vertical elevation references.
 - 2. Any subsequent re-staking due to CMAR's failure to protect stakes or benchmarks shall be at CMAR's expense.
- B. All other surveying and staking required for the Project shall be provided by the CMAR or Subcontractors pursuant to their respective scopes of work. CMAR shall preserve stakes established by the Owner.
- C. Owner shall be present for all tie-ins to existing waterlines and operation of all valves.
- D. Owner continues to operate and maintain existing treatment facility during construction. CMAR's work shall not interfere with operation and maintenance of the Hill City Wasterwater Treatment Facility.

1.03 WORK UNDER OTHER CONTRACTS

- A. The Owner reserves the right to award additional contracts which may affect the operation of the CMAR.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 11 16

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SECTION 01 12 16
WORK SEQUENCE

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. General Work Sequence.
 - 2. Sequence of Construction.

1.02 GENERAL WORK SEQUENCE

- A. Prior to any work requiring process interruptions, equipment startup, basin transfer, temporary bypass, or treatment changeover, CMAR shall submit a detailed Work Sequence Plan describing sequencing, temporary piping, pumping, control strategies, operator responsibilities, contingency measures, anticipated durations, and required Owner participation. The Work Sequence Plan shall be updated as construction progresses
- B. CMAR shall stay within time restraints for certain construction tasks as identified in the Contract Documents.

1.03 OPERATIONS

- A. The existing wastewater treatment facility shall remain fully operational throughout construction. Construction activities shall be sequenced to maintain continuous treatment and compliance with the City's NPDES permit unless otherwise approved by the Owner, Engineer, and regulatory agencies.

1.04 SEQUENCE OF CONSTRUCTION

- A. The SBR2 excavation, subgrade preparation, foundation, basin concrete, and associated underground work included in Work Package No. 1 shall be completed prior to commencement of the remaining Work unless otherwise approved by the Owner and Engineer. CMAR shall coordinate all subsequent work with the completed Work Package
- B. CMAR shall perform tasks in the order indicated and within the time constraints specified. This is not an exhaustive list of all work to be completed, but gives general idea of the potential work sequence.
- C. The work sequence provided herein is for the CMAR's information. CMAR shall be free to modify it to meet their needs subject to the approval of the Owner and Engineer.

1. Complete Sequencing Batch Reactor 2 (SBR2) excavation and concrete work as part of Work Package 1.
 2. Construct new Pretreatment Building (PTB) and connect to SBR2.
 3. Install equipment in new PTB and SBR2. Complete construction of these items.
 4. Complete construction of Bypass Lift Station (BLS), remove Return Lift Station (RLS) pumps, install flow control valve in RLS, tie in all piping to BLS.
 - a. Temporarily tie in BLS discharge to existing pretreatment building. Filter backwash, clariflocculator scum, and bypass pond flows will flow to BLS. Temporary flow to Pond 3 is acceptable to make necessary connections.
 5. Demolish existing Backwash Basin.
 6. Tie in SBR2 WAS line to existing Aerobic Digester (AD). Construct SBR2 Decant Lift Station (SDP) and decant line to Flow Leveling Basin.
 7. Temporarily divert flow to Bypass Pond. Connect new PTB to plant influent sewer line.
 - a. Keep line temporarily plugged, influent flow remains to existing PTB/SBR1.
 - b. Install Flow Meter 1 manhole and equipment.
 - c. Install improvements to Diversion Manhole (DVM).
 - d. Install Flow Meter 2 manhole and equipment.
 8. Draw down SBR1 to make connection from new PTB to SBR1. Pump SBR1 mixed liquor to SBR2 while maintaining sufficient biomass inventory to facilitate successful recommissioning of SBR1 following completion of improvements. After connection is complete, pump mixed liquor from SBR2 back to SBR1.
 9. Connect BLS to new PTB.
 10. Route influent flow to new PTB and SBR1.
 11. Fully commission SBR2.
 - a. Monitor treatment performance of SBR2. Flow to the Flow Leveling Basin and final treatment processes is allowed only if SBR2 meets performance requirements.
 - b. Verify stable operation of SBR2 for the minimum period specified in the Contract Documents before removing SBR1 from service.
 12. Drain SBR1 to Bypass Pond. Complete construction of improvements in SBR1.
 13. Demo equipment in existing PTB and process building. Install new equipment in existing process building.
 14. Re-seed SBR1 with sludge from SBR2 and begin start-up of SBR1.
 15. Complete remaining work and site restoration.
- D. In an attempt to prevent any inadvertent disruptions to the City of HILL CITY wastewater system, the CMAR, through the Owner's Resident Project Representative, shall adequately communicate intended plans and activities with the Engineer, for approval by Owner.

- E. Owner recognizes the CMAR will require scheduled shutdowns in order to complete some necessary tasks. The Owner will make a reasonable attempt to alter operational procedures, including temporary shutdowns, to allow for CMAR work. CMAR shall notify Owner and Engineer of planned shut downs in accordance with the Contract Documents.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 12 16

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SECTION 01 14 00
WORK RESTRICTIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. CMAR Use of Site and Premises.
 - 2. Owner Occupancy Requirements.
 - 3. Access to Streets and Highways.
 - 4. Special Work Requests.

1.02 CMAR USE OF SITE AND PREMISES

- A. Maintain access to Black Hills Energy substation at all times.
- B. Limit use of Site and premises to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
- C. Coordinate performance of all Work with Owner operations.
- D. Coordinate use of premises under direction of Engineer. CMAR shall confine construction equipment, storage of materials and equipment and operations of workmen to areas permitted by law, ordinances, permits, or requirements of Contract Documents, and shall not unreasonably encumber premises with construction equipment or other materials or equipment.
- E. Assume full responsibility for the protection and safekeeping of products under this Contract, stored on the site.
- F. Move any stored products, under CMAR's control, which interfere with operations of the Owner.
- G. Construction personnel may park only in areas designated by the Owner.
- H. Obtain and pay for use of storage or work areas needed for operations.
- I. CMAR shall notify and coordinate with Police Department, Fire Department, and Hospital/Ambulance Services. Notice shall include work schedule as construction proceeds, when work affects or obstructs intersections and streets, and when work is completed, or suitable access is available in streets and intersections.

- J. CMAR shall provide the name, address, and telephone number of person who has access to equipment and is authorized to make emergency repairs to CMAR's work, such as to correct trench cave-ins, move excavated material, and correct other problems during weekends and off-work hours, so access can be maintained for firefighting equipment, and to maintain barricades for public safety.
- K. The CMAR must be satisfied through personal examination of the Site(s) as to all local conditions affecting their performance of the Contract. The CMAR is deemed to accept such conditions as found to exist.
- L. The CMAR shall preserve all monuments, benchmarks, reference points, and stakes. In case of destruction thereof, the CMAR will be charged with expense of replacement and shall be responsible for any mistake or loss of time that may be caused. Permanent monuments or benchmarks which must be removed or disturbed shall be protected until properly referenced for relocation. The CMAR shall furnish materials and assistance for the proper replacement of such monuments or benchmarks.
- M. Damaged Property:
 - 1. Patch and or clean existing improvements and restore damage of property on, or adjacent to the Site(s) occasioned by the Work, including but not limited to, lawns, walks, driveways, roadways, curbs, pavements, structures, and utilities which are cut or damaged by operations and are not designated for removal, relocation, or replacement in the course of construction.
 - 2. If any direct or indirect damage is done to public or private property resulting from any act, omission, neglect, or misconduct, the CMAR shall restore the damaged property to a condition equal to or better than that existing before the damage at no additional cost to the Owner. Repair, rebuild, or restore property as directed or make good such damage in an acceptable manner.
 - 3. Provide written acceptance of restoration by authority or Owner.
- N. Existing Facilities:
 - 1. The CMAR shall take all necessary field measurements affecting all existing construction, wiring, piping, and equipment in this Contract and shall be solely responsible for proper fit between all Work under the Contract and existing structures, piping, and equipment.
 - 2. Dimensions given on the drawings related to existing structures are based upon existing construction record drawings and it shall be the responsibility of the CMAR to verify the accuracy of all dimensions shown for existing structures, piping, and equipment. Any discrepancies shall be brought to the attention of the Engineer prior to the start of new

construction or ordering of any materials. CMAR shall be responsible for any materials ordered that will not fit due to the failure to verify any discrepancies of existing structures, piping, and equipment prior to the start of new construction.

O. Existing Utilities:

1. Existing underground utilities, as shown on the drawings, are located in accordance with available data but locations shall be determined by the CMAR prior to beginning construction. A utility locate is required prior to any excavation.
2. CMAR shall protect all existing utilities and provide temporary removal and replacement or relocation as required for completion of the Work in the contract documents. No additional payment shall be made for this work.
3. Existing utilities not shown on the drawings and requiring relocation shall be exposed by the CMAR without damage. If damaged, the CMAR shall bear the responsibility and cost of repair or replacement.

P. Environmental Resources:

1. Protect environmental resources within the project boundaries and those affected outside the limits of permanent work during the entire period of this Contract. Confine activities to areas defined by the contract documents.
2. Prior to construction, identify all land resources to be preserved within the work area. Do not remove, cut, deface, injure, or destroy land resources including trees, shrubs, vines, grasses, topsoil, and land forms without permission from the Owner. Do not fasten or attach ropes, cables, or guys to trees for anchorage unless specifically authorized, or where special emergency use is permitted.
3. Protect trees, shrubs, vines, grasses, land forms, and other landscape features shown on the drawings to be preserved by marking, fencing, or using other approved techniques.
4. The erosion and sediment controls selected and maintained by the CMAR shall be such that water quality standards are not violated as a result of the CMAR's activities. Maintain temporary erosion and sediment control measures such as fencing, berms, dikes, drains, sedimentation basins, grassing, and mulching, until permanent drainage and erosion control facilities are completed and operative.
5. See Section 01 57 00 for additional requirements.

1.03 OWNER OCCUPANCY REQUIREMENTS

- A. Cleanliness is crucial and the CMAR shall maintain a clean and orderly site at all times.

- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations. Schedule all Work to accommodate this requirement. No interruption will be permitted which adversely affects the degree of service the Owner provides. CMAR shall provide temporary facilities and make temporary modifications as necessary to keep the facilities in operation during the construction period.
- C. Pre-plan, schedule, coordinate, and stage for required materials, manpower, contractors, subcontractors, etc. to complete critical elements of Work.
- D. Existing materials and equipment removed and not reused as part of the Work, and not identified elsewhere in the contract documents for salvage, shall be properly disposed of by the CMAR at no additional cost to Owner.

1.04 ACCESS TO STREETS AND HIGHWAYS

- A. Maintain suitable means of access for property owners abutting streets and highways and access roads involved in construction, except as specifically permitted otherwise by Owner.
- B. Whenever construction is stopped due to inclement weather, weekends, holidays, or other reasons, suitable access shall be provided for all property owners.
- C. Maintain access for firefighting equipment and access to fire hydrants.
- D. Maintain two-way traffic at all times during construction on all impacted streets and highways.

1.05 SPECIAL WORK REQUEST

- A. Saturday and Sunday work is allowed for the purposes of clean-up work only (no underground work shall be allowed) by the CMAR without prior written approval from the Engineer or Owner. Work shall not start on Saturday or Sunday before 9:00 AM.
- B. If the CMAR plans to conduct work other than clean-up work, the CMAR shall submit a Special Work Request to the Engineer and Owner for written approval. Engineer shall provide the CMAR with the appropriate form. All requests shall be made at least two (2) weeks in advance of scheduled work.
- C. Special Work Request restrictions shall apply for South Dakota state observed holidays. CMAR shall submit a Special Work Request if work is scheduled for these dates.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 14 00

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SECTION 01 19 00
SPECIAL PROVISIONS

PART 1 - GENERAL

1.01 GENERAL

- A. In addition to the liquidated damages as stated in the agreement between Owner and CMAR, CMAR will be responsible for payment of any legitimate claims made by other contractors working within the area who have incurred a loss as a result of CMAR's failure to complete the Work of this project by the specified completion date(s).

1.02 MISCELLANEOUS ITEMS

- A. Any miscellaneous items needed to complete the project per plans and specifications that are not listed as pay items shall be considered incidental to the contract and no direct compensation shall be made.

1.03 UTILITY LOCATION AND PROTECTION

- A. The CMAR shall be responsible for coordinating with all utility companies for location of buried utilities prior to excavation. All measures necessary to locate and protect utilities during construction shall be taken. All damage to utilities resulting from construction activities shall be the sole responsibility of the Contractor performing the Work and be repaired at such Contractor's expense.
- B. All bracing for light/utility poles required during open excavations shall be coordinated by and the responsibility of the CMAR. All costs of equipment, vehicles, personnel, or private service shall be incidental to the cost of the project.

1.04 EROSION CONTROL

- A. Measures (silt fence, drainage swales, bales, etc.) shall be established at the beginning of construction and maintained during the entire length of construction to control erosion. An erosion control plan shall be submitted to the South Dakota Department of Agriculture and Natural Resources (SDDANR) per Special Provisions before commencement of Work. The erosion control plan shall be updated at the Construction Progress Meetings. Areas that are subject to severe erosion and/or sedimentation are to receive additional erosion control measures, as directed by Engineer. Failure to implement the controls and practices outlined, may result in violation of provisions of the Clean Water Act.
- B. CMAR shall be responsible for maintenance of erosion and sediment resulting from construction within the project limits. All land-disturbing activities shall be coordinated and conducted so as to minimize the size of the area to be exposed

at any one time and to minimize the time of exposure. All land-disturbing activities shall also be coordinated and conducted so as to minimize off-site sedimentation damage.

- C. CMAR shall be responsible for periodically cleaning out and disposing of all sediment off-site during and at the completion of the project. Additional on-site protection may be needed so that sediment is not permitted to leave the project boundaries.
- D. The CMAR is responsible for removing the temporary erosion and sediment control devices and verify all storm drainage structures are clean, including flumes, pipes, and ditches once final stabilization has occurred. Maintain temporary erosion control devices until permanent facilities are constructed and final stabilization is in place and performing adequately.
- E. CMAR shall be responsible for obtaining the permit and meeting the requirements of the State NPDES General Storm Water Permit, if applicable.
- F. CMAR shall be responsible for obtaining the permit and meeting the requirements of the City of Hill City General Storm Water Permit.
- G. Per the permit requirements the CMAR shall be responsible for periodically cleaning out and disposing of all sediment off-site during and at the completion of the project. The CMAR is also responsible for removing the temporary erosion and sediment control devices. Additional responsibilities include verification that all storm drainage structures are clean, including flumes, pipes, and ditches once final stabilization has occurred. Maintain temporary erosion control devices until permanent facilities are constructed and final stabilization is in place and performing adequately.

1.05 DEWATERING

- A. Equipment shall be provided to remove and dispose of water entering excavations and trenches. Excavations and trenches shall be maintained dry during sub-grade preparation and continually thereafter until the structure is built or the pipe is installed, to the extent that no damage from hydrostatic pressure, flotation, or other detrimental effects result.
- B. All excavations or trenches below groundwater elevation shall be dewatered and water surface maintained 2 feet (60.96 cm) below the excavation. Surface water shall be diverted or otherwise prevented from entering excavations or trenches.
- C. The CMAR shall be responsible for obtaining all necessary permits as related to dewatering and water discharge and to comply with all stipulations of such permits.

1.06 SITE CONDITIONS

- A. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the CMAR. The information is made available for the convenience of the CMAR and is in no way, shape, or form considered a part of this Contract.
- B. CMAR shall determine to CMAR's own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- C. CMAR may perform additional test borings or other exploratory operations at CMAR's own expense. CMAR shall make arrangements for any additional soils investigation with Owner.
- D. No claim for additional payment will be accepted due to the nature of subsurface conditions in which the work is to be performed.
- E. Do not commence construction of structure foundation until soil test results are confirmed.

1.07 SURFACE WATERS

- A. All construction which directly or indirectly impacts on aquatic systems will be managed to minimize impacts. All attempts will be made to prevent the contamination of water at construction sites from fuel spillage, lubricants, and chemicals, by following safe storage and handling procedures. Stream bank and stream bed erosion and disturbances will be controlled to minimize and/or prevent silt movement, nutrient upsurges, plant dislocation, and any physical, chemical, or biological disruption. The use of pesticides or herbicides in or near these systems is forbidden without approval from the appropriate governing agency.

1.08 SOILS

- A. Prevent the erosion of exposed soil surfaces by inhibiting the movement of exposed particles and trapping sediment dams or berms, diversion dikes, hay bales as erosion checks, riprap, mesh or burlap blankets to hold soil during construction, and immediately establishing vegetative cover on disturbed areas after construction is completed. Fragile and sensitive areas such as wetlands, riparian zones, delicate flora, or land resources will be protected against compaction, vegetation loss, and unnecessary damage.

1.09 TREE PROTECTION, REMOVAL AND REINSTALL, OR REPLACEMENT

- A. The CMAR is responsible for protection and care of trees within the construction limits of the Project unless otherwise indicated on the drawings. Trees identified

for protection but damaged or killed as a direct result of construction activities will be replaced. Replacement of damaged trees must be of equal quality, size, and type of tree removed and grubbed during construction.

- B. If removal and reinstallation is allowed, the CMAR shall be responsible for the following provisions:
 - 1. If tree is leafed at the time of transplant, spray leaves with an anti-transparent to decrease chances of transplant shock. Not required for dormant trees.
 - 2. CMAR is responsible for finding a holding area for temporary planting.
 - 3. After planting at temporary holding area, work loose soil into area between the hole and tree plug to fill all air cavities. CMAR is responsible for watering and maintaining health of tree.
 - 4. Add 3-inch layer organic mulch to surface of root ball.
 - 5. Repeat procedure when transplanting tree to original site. Owner has final decision for location of permanent placement.
 - 6. CMAR is responsible for the health of the trees. Trees that die during temporary or permanent transplanting shall be replaced with equal quality, size, and type of tree at CMAR's expense.

1.10 SEEDING

- A. All seeding shall be as specified in Section 32 92 19, when seeding is required.

1.11 EXISTING DRIVEWAYS, WALKS, PATIOS, BUILDINGS, SHRUBS & TREES

- A. The CMAR shall exercise absolute care to minimize damage to existing property improvements. Any damage to existing property improvements due to carelessness shall be repaired at the CMAR's expense.

1.12 HAUL ROADS

- A. The CMAR shall take whatever steps are necessary to ensure that no overloading is done by himself or his sub-Contractors. This will insure that no city, county, state or other restrictions are violated. It shall be the responsibility of the CMAR to familiarize himself with all local regulations before starting construction. Any road damaged by the CMAR shall be repaired to the original condition at the CMAR's expense, to the satisfaction of the Engineer.

1.13 TRAFFIC CONTROL

- A. It shall be the CMAR's responsibility to install barricades, lights, etc., at all potentially dangerous locations, whether directed to or not by the Engineer. The traffic control and signing shall be in conformance with latest edition of the M.U.T.C.D.

1.14 PERMITS

- A. CONTRACTOR shall obtain such permits and licenses that are required for completion of the Work. Permits include, but are not limited to;
1. Permit and/or coordination with the State Electrical Inspector, as required.
 2. Building Permits from the City of Hill City as required.
 3. All other Permits required by work.

1.15 ADJACENT WORK/ACTIVITY

- A. CMAR and Subcontractors shall be aware that adjacent work will be conducted near the project site(s). CMAR shall coordinate the Work with Engineer, Owner, and Contractors/Subcontractors, as necessary. Potential adjacent work includes, but is not limited to:
1. Sturgis Bike Rally
 2. Miscellaneous street work throughout the City of Hill City

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 19 00

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SECTION 01 29 00
PAYMENT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Format and Preparation of Applications.
2. Schedule of Values
3. Submittal Procedures.
4. Substantiating Data.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures.
2. Section 01 77 00 - Closeout Procedures.

1.02 FORMAT AND PREPARATION OF APPLICATIONS

A. Utilize: Engineers Joint Contract Document Committee (EJCDC) Application for Payment Form (C-620, 2013 Edition).

B. Preparation

1. Present required information in typewritten form.
2. Execute certification by signature of authorized officer.
3. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored Products.
4. 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.
5. Prepare Application for Final Payment as specified in Section 01 77 00.

1.03 SCHEDULE OF VALUES

A. Submit:

1. Typed schedule of values in format similar to EJCDC Application for Payment (C-620, 2013 Edition).
2. In duplicate within 15 days after date of Owner-Contractor Agreement.

B. Format:

1. Utilize the Table of Contents within Contract Documents.

2. Identify line items corresponding with number and title of Specification Section.
 3. Identify site mobilization, bonds, and insurance.
 4. Include within each line item a direct proportional amount of Contractor's overhead and profit.
- C. Revise Schedule of Values to list approved Change Orders, and submit with each Application for Payment.

1.04 SUBMITTAL PROCEDURES

A. Submittals

1. Three (3) copies of each Application for Payment.
2. Updated construction schedule with each Application for Payment.
3. Payment Periods: As stipulated in the Agreement.
4. Submit with transmittal letter as specified for Submittals in Section 01 33 00.
5. Administrative actions which must precede or coincide with submittal of final application for payment include:
 - a. Submit lien waivers, warranties and bonds, and project record documents with final application for payment.
 - b. Completion of all work not included in substantial completion as defined in General and Supplementary Conditions.
 - c. Completion of project closeout procedures as indicated in Section 01 77 00.
 - d. Removal of temporary facilities and services.
 - e. Removal of surplus materials, rubbish, or similar elements.
 - f. Final cleaning.
 - g. Transmittal of project construction record documents to Owner and Engineer.
 - h. Consent of surety for final payment.

1.05 SUBSTANTIATING DATA

- A. When Engineer requires substantiating information, submit data justifying dollar amounts in question.
- B. Beginning with the second Application for Payment, each Application shall include an affidavit from 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.
- C. 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.

- D. Provide copies of invoice(s) for payment of materials stored on-site. Payment will not be made for materials that are not stored on-site or within a bonded warehouse that has been approved by Engineer and Owner.
- E. Contractor shall supply substantiating information in compliance with federal and state requirements for monthly utilization reports and weekly prevailing wage and labor rates for laborers on-site.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 29 00

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SECTION 01 31 13
PROJECT COORDINATION

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes:

1. Coordination and project conditions.
2. Field engineering.

B. Related Sections include:

1. Section 01 11 13 - Work Covered by Contract Documents.
2. Section 01 11 16 - Work by Owner.
3. Section 01 29 00 - Payment Procedures.
4. Section 01 33 00 - Submittal Procedures.
5. Section 01 77 00 - Closeout Procedures.

1.02 COORDINATION AND PROJECT CONDITIONS

A. General:

1. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
2. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate Work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
3. Coordinate space requirements, supports, and installation of mechanical and electrical Work that are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
4. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
5. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion and for portions of Work designated for Owner's partial occupancy.

6. Coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

B. Responsibilities of the CMAR :

1. Afford other Contractors reasonable opportunity for the introduction and storage of their materials and equipment and the execution of their Work.
2. Connect and coordinate Work with other Contractors Work as required by the Contract Documents.
3. Allocate and coordinate use of Site for field offices and construction trailers and for access, traffic, and parking facilities.
4. Instruct and coordinate the use of temporary utilities and construction facilities.
5. Coordinate field engineering and layout Work.
6. Verify all shop drawing dimensions.
7. Coordinate the Work of the individual Contractors.
8. Submit (and revise) progress schedule in accordance with Section 01 33 00 - Submittal Procedures coordinating the entire project construction schedule.
9. Organize and submit Applications for Payment. Submit applications on EJCDC C-620 forms for review by Engineer.
10. Submit shop drawings, product data, and samples in accordance with Section 01 33 00 - Submittal Procedures.
11. Submit request for interpretation of Contract Documents and obtain instructions through Engineer.
12. Process requests for Change Orders through Engineer.
13. Organize all closeout submittals and preliminary inspection reports for transmittal to Engineer. Organize all record drawings and submit to Engineer. Review all drawings before submitting to Engineer.
14. Notify Engineer when all trades are ready for final inspection and organize Substantial and Final inspections.
15. Provide record drawing information to Engineer.
16. Ensure punch list items are completed prior to scheduling final inspection by Engineer.

1.03 FIELD ENGINEERING

- A. The Owner and Engineer will provide control datum for construction is that shown on Drawings.
- B. CMAR shall locate and protect survey control and reference points.
- C. Owner will provide services of a licensed surveyor in order to establish required elevations, lines and levels utilizing recognized engineering practices. The CMAR is required to install work per drawings dimensions and elevations.

- D. CMAR shall confirm Drawing dimensions and elevations. Notify Engineer concerning errors or ambiguities.
- E. Site service utilities are shown in their approximate locations on the Drawings. CMAR shall be responsible to field verify all utility locations as required to accommodate construction activities.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 31 13

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SECTION 01 31 19
PROJECT MEETINGS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Preconstruction meeting.
 - 2. Site mobilization meeting.
 - 3. Progress meetings.
 - 4. Preinstallation meeting.
- B. Related Sections include:
 - 1. Section 01 11 13 - Work Covered by Contract Documents.
 - 2. Section 01 11 16 - Work by Owner.
 - 3. Section 01 77 00 - Closeout Procedures.

1.02 PRECONSTRUCTION MEETING

- A. Engineer will schedule a meeting at the Project Site after Notice of Award.
- B. Attendance required by
 - 1. CMAR.
 - 2. CMAR's superintendent.
 - 3. Owner.
 - 4. Engineer.
 - 5. Major Subcontractor(s).
 - 6. South Dakota Department of Agriculture and Natural Resources.
- C. Agenda:
 - 1. Contract Forms and Conditions of the Contract.
 - 2. Distribution of Contract Documents.
 - 3. Submission of list of Subcontractors, list of products, schedule of values, and progress schedule.
 - 4. Designation of personnel representing the parties in Contract, and the Engineer.
 - 5. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 - 6. Scheduling.
 - 7. Use of premises by Owner and CMAR.
 - 8. Procedures for testing.

9. Procedures for maintaining record documents.
 10. Requirements of the primacy agencies.
- D. Engineer will record minutes and distribute copies after meeting within fourteen (14) days to participants and those affected by decisions made.

1.03 SITE MOBILIZATION MEETING

- A. Engineer and Owner will schedule a meeting at the Project Site prior to CMAR occupancy.
- B. Attendance required by:
1. CMAR.
 2. CMAR's Superintendent(s).
 3. Owner.
 4. Engineer.
 5. Major Subcontractor(s).
- C. Agenda:
1. Use of premises by Owner and CMAR.
 2. Owner's requirements and partial occupancy.
 3. Construction facilities and controls provided by Owner.
 4. Temporary utilities provided by Owner.
 5. Survey and building layout.
 6. Security and housekeeping procedures.
 7. Procedures for testing.
 8. Requirements for start-up of equipment.
 9. Inspection and acceptance of equipment put into service during construction period.
 10. Procedures for maintaining record documents.
- D. Engineer will record minutes and distribute copies after meeting within fourteen (14) days to participants and those affected by decisions made.

1.04 PROGRESS MEETINGS

- A. Engineer will:
1. Schedule and administer meetings at the Project site throughout progress of the Work at weekly intervals, or as deemed necessary by the Engineer.
 2. Make arrangements for hosting meetings.
- B. Attendance required by:
1. CMAR
 2. CMAR(s) Job Superintendent.

3. Owner.
4. Engineer.
5. Major Subcontractors and suppliers.
6. Others as appropriate to agenda topics for each meeting.

C. Agenda:

1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems, and decisions.
4. Identification of problems which impede planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding Work period.
10. Coordination of projected progress.
11. Maintenance of quality and Work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. Other business relating to Work.

- D. Engineer will record minutes and distribute copies within seven (7) days after meeting to participants and those affected by decisions made.

1.05 PREINSTALLATION MEETING

- A. When required in individual Specification sections, convene a preinstallation meeting at the site prior to commencing Work of the section.

1. Require attendance of parties directly affecting, or affected by, Work of the specific section.
2. Notify Engineer seven (7) days in advance of meeting date.
3. Prepare agenda and preside at meeting.
4. Review conditions of installation, preparation and installation procedures.
5. Review coordination with related Work.

- B. Engineer will record minutes and distribute copies within fourteen (14) days after meeting to participants and those affected by decisions made.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 31 19

SECTION 01 33 00
SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes:

1. Submittal Procedures.
2. Submittal Schedules
3. Construction Progress Schedules.
4. Proposed Products List.
5. Tabulation of Subcontractors.
6. Tabulation of Suppliers.
7. Request for Interpretation.
8. Product Data.
9. Shop Drawings.
10. Samples.
11. Test Reports.
12. Manufacturer's Certificates.
13. Manufacturer's Instructions.
14. Manufacturer's Field Reports.
15. Excessive Shop Drawing Reviews.
16. Prevailing Wage Compliance.
17. DBE Compliance.
18. 18. Manufacturer's Certification of the Use of AIS.
19. CMAR's Certification of the Use of AIS.

B. Related Sections include:

1. Section 01 45 00 - Quality Control.
2. Section 01 77 00 - Closeout Procedures.
3. Section 01 78 23 - Operation and Maintenance Data.
4. Divisions 2 through 46.

1.02 SUBMITTAL PROCEDURES

- A. Transmit each submittal with Engineer accepted form.
- B. Sequentially number the transmittal form. Submit revised submittals with original number and a sequential alphabetic suffix.
- C. CMAR shall send each submittal in electronic format to be distributed by Engineer for review. Upon approval, CMAR shall submit four (4) hard copies to be retained by ENGINEER and ENGINEER'S Subconsultants.

- D. Identify Project, CMAR, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate.
- E. CMAR shall completely review all submittal materials prior to submission to Engineer. Apply CMAR's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents.
- F. Schedule submittals to expedite the Project, and deliver to Engineer at business address. Coordinate submission of related items.
- G. ENGINEER will attempt to complete a review of each submittal in a timely manner within 30 calendar days of receipt of each submittal. Failure of ENGINEER to review a submittal within the estimated review timeframe shall not be basis for the CMAR to request or receive additional Contract Price or Contract Time.
- H. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work. Highlight and/or clearly designate specific product details and information so as to confirm product meets or exceeds Specifications.
- I. Provide space for CMAR and Engineer review stamps.
- J. When revised for resubmission, identify all changes made since previous submission.
- K. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements. Clearly transmit Engineer review comments to suppliers and subcontractors as required to minimize product delivery errors and miscommunications.
- L. Submittals not requested will not be recognized or processed.
- M. ENGINEER will review submittals in order received unless CMAR requests, in writing, a revised order of review. A revision in order may add to the length of review time required for previously submitted submittals.
- N. Submittal of more than three major submittals per week may add to the required length of review time. ENGINEER shall notify CMAR of submittal review scheduling conflicts.

1.03 SUBMITTAL SCHEDULES

- A. CMAR shall submit a schedule of submittal dates for shop drawings, product data, and samples.

- B. The submittal schedule shall identify specification sections and anticipated submittal dates. Indicate any critical submittals and dates for ENGINEER'S review.
- C. Provide decision dates for selection of finishes and samples.

1.04 CONSTRUCTION PROGRESS SCHEDULES

- A. Submit initial schedule in duplicate within 15 days after date of Owner-CMARAgreement.
- B. Revise and resubmit as required.
- C. Submit revised schedules with each Application for Payment, identifying changes since previous version. Application for Payment will not be processed until updated construction schedule has been submitted.
- D. Prepare schedules as a horizontal bar chart with separate bar for each major portion of Work or operation, identifying first workday of each week as well as the proposed start and completion dates of each major portion of Work.
- E. Sheet Size: Minimum 11x17 inches. Large sizes than 11x17 inches shall be in multiples of 8½x11 inches.
- F. Content
 - 1. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction. Indicate the early and late start, early and late finish, float dates, and duration.
 - 2. Identify each item by Specification section number.
 - 3. Identify Work of separate stages and other logically grouped activities.
 - 4. Provide sub-schedules to define critical portions of the entire schedule.
 - 5. Include conferences and meetings in schedule.
 - 6. Indicate estimated percentage of completion for each item of Work at each submission.
 - 7. Provide separate schedule of submittal dates for shop drawings, product data, and samples, and dates reviewed submittals will be required from Engineer. Allow sufficient time for review by Engineer. Indicate decision dates for selection of finishes.
 - 8. Coordinate content with schedule of values.
- G. Provide narrative report to define problem areas, anticipated delays, and impact on Schedule.
- H. Distribution
 - 1. Distribute copies of reviewed schedules to Project Site file, Subcontractors, suppliers, and other concerned parties.

2. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

1.05 PROPOSED PRODUCTS LIST

- A. Within fifteen (15) days after date of Owner-CMAR Agreement, submit list of major Products proposed for use, with name of manufacturer, trade name, and model number of each Product.
- B. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

1.06 TABULATION OF SUBCONTRACTORS

- A. CMAR shall submit a complete list of subcontractors who will provide work on the project.
- B. The submitted list shall include the following information for each subcontractor:
 1. Name
 2. Address
 3. Type of work to be provided
 4. Applicable specifications sections
 5. Contact person
- C. CMAR'S use of specific subcontractors shall be subject to the requirements included in the specifications.

1.07 TABULATION OF SUPPLIERS

- A. CMAR shall submit a list of suppliers who will provide materials, equipment, or components which are integral to the Work.
- B. The submitted list shall include the following information for each subcontractor:
 1. Name
 2. Address
 3. Type of work to be provided
 4. Applicable specifications sections
 5. Contact person
- C. CMAR'S use of specific suppliers for providing equipment, materials, or components shall be subject to the requirements of the specifications.

1.08 REQUESTS FOR INTERPRETATION

- A. CMAR shall submit in writing all requests for interpretation or for information regarding the Contract Documents on the form provided by the ENGINEER.

- B. ENGINEER does not guarantee that a response can be provided in the amount of time requested, but ENGINEER shall respond in writing to CONTRACTOR'S request within a reasonable amount of time given the extent of the request for interpretation of information required.

1.09 PRODUCT DATA

- A. Submitted to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.
- B. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record document purposes described in Section 01 77 00.
- C. Submit the number of copies that the CMAR requires, plus five (5) copies that will be retained by the Engineer and Engineer's Subconsultant.
- D. Mark each copy to identify applicable Products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- E. Indicate Product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service of functional equipment and appliances.
- F. Premium and High Efficiency Product Data: The City will participate in various rebate programs for premium and high-efficiency equipment and products. Provide Proof of Purchase and Compliance product data as needed to complete the various rebate forms. Rebate forms are included as attachments to Section 01 61 00 - Common Product Requirements.

1.10 SHOP DRAWINGS

- A. Submitted to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.
- B. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record document purposes described in Section 01 77 00.
- C. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

- D. Submit in electronic format for ENGINEER'S review. Upon approval, submit four (4) hard copies that will be retained by the Engineer and Engineer's Subconsultant.
- E. All shop drawings shall be submitted through the CMAR in accordance with the procedures outlined in this specification. Shop drawings received from anyone other than through the CMAR will not be reviewed.
- F. Shop drawings shall include data and technical drawings prepared specifically for this Project, including where required, but not limited to the following:
 - 1. Fabrication drawings
 - 2. Installation drawings
 - 3. Shopwork manufacturing instructions
 - 4. Templates or patterns
 - 5. Coordination drawings
 - 6. Schedules
 - 7. Design calculations
- G. Shop drawings shall contain complete detail showing conformance with the Contract Documents and such other specified information as required, including but not limited to the following
 - 1. Related work with applicable cross references
 - 2. Physical configuration
 - 3. Dimensional information, including any variations from actual conditions
 - 4. List of materials
 - 5. Structural construction and assemblies
 - 6. Anchor bolt details showing type, size, embedment, and locations
 - 7. Machinery and equipment details
 - 8. Auxiliary items to machinery and equipment
 - 9. Protective coatings and factory finishes
 - 10. Electrical information including motor sizes, wiring and circuit diagrams, and instrumentation
 - 11. Testing results
 - 12. Warranty information
- H. Detail all connections required to complete the work.
- I. Approval of shop drawings by ENGINEER shall not relieve the CMAR from responsibility of deviations from drawings or specification, unless deviations or changes have been brought to ENGINEER'S attention at time of submission, nor shall it relieve the CMAR from responsibility for errors or omissions in shop drawings.

1.11 SAMPLES

- A. Submitted to Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
- B. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article above and for record document purposes described in Section 01 77 00.
- C. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
- D. Include identification on each sample, with full Project information.
- E. Submit the number of samples specified in individual Specification sections; one (1) of which will be retained by Engineer.
- F. Reviewed samples that may be used in the Work are indicated in individual Specification sections.
- G. Samples will not be used for testing purposes unless specifically stated in the Specification section.

1.12 TEST REPORTS

- A. Submit for the Engineer's knowledge as Contract Administrator or for the Owner.
- B. Submit test reports for information for the limited purpose of assessing conformance with information given and the design concept expressed in the Contract Documents.
- C. Retain one (1) copy of all test reports and results on-site in a location accessible to Engineer.

1.13 MANUFACTURER'S CERTIFICATES

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

1.14 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.
- C. Refer to Section 01 45 00 - Quality Control, Manufacturers' Field Services article.
- D. Manufacturer's Certification with the Use of American Iron and Steel as required.
- E. CMAR Certification with the Use of American Iron and Steel as required.

1.15 MANUFACTURER'S FIELD REPORTS

- A. Submit reports for the Engineer's benefit as Contract Administrator or for the Owner.
- B. Submit report in duplicate within 15 days of observation to Engineer for information.
- C. Submit the manufacturer's field reports for the limited purpose of assessing conformance with information given and the design concept expressed in the Contract Documents.

1.16 EXCESSIVE SHOP DRAWING REVIEWS

- A. The maximum number of submittal reviews for any one product or specification section shall be two (2).
- B. Compensation for third or subsequent reviews will be required as outlined below:
 - 1. OWNER will compensate ENGINEER for "additional services".
 - 2. OWNER will deduct amount of such compensation from payment to CONTRACTOR.
 - 3. ENGINEER'S compensation shall be at ENGINEER'S standard hourly rates, plus reimbursable expenses at cost.

1.17 PREVAILING WAGE COMPLIANCE

- A. Projects requiring prevailing wage rates for the South Dakota Department of Agriculture and Natural Resources will be required to comply with DANR State Revolving Fund General Conditions.

1.18 DBE COMPLIANCE

- A. CMAR shall meet all federal and state requirements.

- B. Within fifteen (15) days of award of the prime contract, copies of all small, minority, and women's business related subagreements between the CMAR and first-tier subcontractors shall be submitted to the OWNER. Subsequently, the prime contractor shall obtain and submit to the OWNER a copy of all small, minority, and women's business related sub-tier contracts within fifteen (15) days after execution of same.
- C. During construction, the prime contractor shall identify the completion date and actual final dollar value of work completed pursuant to each small, minority, and women's business subagreement and sub-tier contract. Any and all changes in previously reported anticipated small, minority, and women's business utilization shall be reported to the OWNER promptly, in writing, with appropriate documentation and reasons.
- D. In the event the CMAR fails to conform to its small, minority, and women's business obligations, it shall explain to the OWNER, in writing, the reason for non-utilization of the small, minority, and women's business. If there is non-utilization without good cause, the OWNER will advise the CMAR, in writing, of corrective actions to be initiated.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 33 00

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SECTION 01 45 00
QUALITY CONTROL

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).
- C. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils; 2017, with Editorial Revision (2018).
- D. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

1.02 SUMMARY

- A. Section includes:
 - 1. Quality Assurance - Control of Installation.
 - 2. Tolerances.
 - 3. References and Standards.
 - 4. Inspection and Testing Services.
 - 5. Manufacturers' Field Services.
- B. Related Sections include:
 - 1. Section 01 33 00 - Submittal Procedures.
 - 2. Section 01 45 16 - CMAR Quality Control.
 - 3. Section 01 75 00 - Starting and Adjusting.

1.03 QUALITY ASSURANCE - CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturer's instructions, including each step in sequence.
- C. Should manufacturer's instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on Contract Drawings, shop drawings, or as instructed by the manufacturer.
- G. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.04 TOLERANCES

- A. Monitor fabrication and installation tolerance control of Products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.
- C. Adjust Products to appropriate dimensions; position before securing Products in place.

1.05 REFERENCES AND STANDARDS

- A. For Products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents, except where a specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. Neither the contractual relationships, duties, nor responsibilities of the parties in Contract nor those of the Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.06 TESTING RESPONSIBILITIES

- A. CMAR's Responsibility:
 - 1. CMAR shall be responsible for all quality control testing and inspections including mill tests, factory tests, qualification tests, laboratory tests, and field tests.
 - 2. Quality control required by codes or ordinances, or by the plan approval authority, unless otherwise provided in the Contract Documents.
 - 3. CMAR's convenience testing.

4. Coordinate with each independent agency to accommodate required services with minimum delay in progress of work, and to avoid moving or replacing work. Schedule times for quality control services.
 5. Cooperate with independent agencies performing required quality control services. Notify testing agency sufficiently in advance of operations to permit assignment of personnel. Provide auxiliary services as required, including, but not limited to the following:
 - a. Providing access to work
 - b. Taking samples or assistance with taking samples
 - c. Delivery of samples to testing laboratories
 - d. Security and protection of samples and test equipment at Site
 6. Tests as required by the Contract Documents that include, but are not limited to proctors, pressure tests, leakage tests, concrete testing, and bacteria testing. All tests requiring the services of a laboratory to determine compliance with the Contract Documents shall be performed by an independent commercial testing laboratory acceptable to the Engineer. The laboratory shall be staffed with experienced technicians properly equipped, and fully qualified to perform the tests in accordance with the specified standards.
 7. The CMAR shall provide the Engineer with a written schedule indicating dates for specific testing and inspection services to be performed. The schedule shall be updated as required to give the Engineer at least one week's advance notice.
 8. The CMAR shall maintain a set of project record drawings that are updated daily that will be turned over to the Engineer at the completion of the project.
 9. Asphalt, concrete and flowable fill mix designs and aggregate quality tests are to be provided by the CMAR at the CMAR's expense.
 10. The CMAR shall arrange for and pay for all tests required not specifically identified in 1.06.B as being performed by the Engineer or provided by the Owner.
- B. Owner's Responsibility: The Owner shall provide the following services at no cost to the CMAR except as required for retests as defined in the Contract Documents:
1. The Engineer will periodically review compaction of backfill and base course using Proctor information supplied by the CMAR. These tests are only to determine if the material is generally complying with the Contract Documents. It is the responsibility of the CMAR to provide his own quality control and to insure that this level of compaction is constant in all locations.
 2. The Engineer will review concrete for slump, air content and cast cylinders for strength testing. The CMAR, at the direction of the Engineer, will ship the cylinders to an independent testing agency to be

tested at the CMAR's expense. One set of 4 concrete cylinders will be cast by the Engineer for every 50 cyds. of concrete placed with a minimum of one set of cylinders per project.

3. Hydrostatic, Leakage and Bacteriological Testing will be witnessed by the Owner's representative at no additional cost to the CMAR on the initial test. Subsequent tests required due to failures of the initial hydrostatic, leakage and bacteriological tests will be paid for by the CMAR. The cost of the project engineer, field inspector, and engineering technicians assigned to this contract shall be charged to the CMAR by the Owner.
4. The Engineer will review compaction of asphalt using Marshall information supplied by the CMAR. These tests are only to determine if the material compaction is complying with the Contract Documents. It is the responsibility of the CMAR to insure that this level of compaction is constant in all locations.

C. Retesting Responsibility:

1. Where results of quality control prove unsatisfactory and do not indicate compliance with Contract Documents all costs associated with retesting is the CMAR's responsibility.
2. The costs for retesting of Owner responsible quality control shall be deducted from the Contract amount by supplemental agreement.

1.07 INSPECTION AND TESTING SERVICES

- A. CMAR shall appoint, employ, and pay for specified services of an independent firm to perform testing, including:
 1. Concrete materials and mix designs.
 2. Asphaltic materials and mix designs.
 3. Embedment and backfill materials.
 4. Bacteriological testing.
 5. Weld Radiographs and Weld Inspection Report, including metal roof deck welding.
 6. All other tests and engineering data required for Engineer's review of materials and equipment proposed to be used in the Work. CMAR shall obtain Engineer's acceptance of the testing firms before having services performed, and shall pay all costs for these testing services. All costs for testing shall be incidental.
- B. The independent firm will perform tests and other services specified in individual specification sections and as required by the Engineer.
- C. Testing and source quality control may occur on or off the project site. Perform off-site testing as required by the Engineer or the Owner.

- D. Reports will be submitted by the independent firm to the Engineer and CMAR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- E. CMAR shall select independent testing agency qualified in accordance with referenced ASTM standards and that is acceptable to the Engineer, if required for certain types of testing.
- F. Comply with pertinent codes, regulations, and industry standards except when more stringent standards or tolerances are specified.
- G. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify Engineer and independent firm 48 hours prior to expected time for operations requiring services.
 - 2. Make arrangements with independent firm and pay for additional samples and tests required for CMAR's use.
- H. Testing does not relieve CMAR from performing Work according to contract requirements.
- I. Re-testing required because of non-conformance to specified requirements shall be performed by the same independent firm on instructions by the Engineer. Payment for re-testing will be paid by the CMAR.

1.08 MILL TESTS

- A. Mill or shop tests shall be conducted and test reports submitted where this type of test is specified.
- B. Mill or shop tests shall be accomplished by the manufacturer or fabricator of the materials. Mill tests may be conducted by an independent testing laboratory. These tests shall be performed in accordance with applicable ASTM standards.

1.09 FACTORY TEST

- A. Factory tests of process, mechanical, and electrical equipment relative to performance, capacity, rating, efficiency, or other such requirements shall be conducted in the factory or shop for each item supplied when this type of test is specified.
- B. Factory testing shall be performed in accordance with applicable standards and test codes.
- C. Where factory tests are required or specified, reports of the test results shall be submitted to Engineer for approval prior to shipment. CMAR shall submit the

number of test reports for approval required by the CMAR plus four (4) copies to be retained by the Engineer.

- D. Factory observation of fabrication procedures, materials used, and testing methods may be performed by a representative of the Owner or Engineer. Owner shall pay for factory observation.

1.10 MANUFACTURERS' INSTRUCTIONS

- A. Comply with manufacturer's instructions in full detail for storage, installation, assembly, installation, start-up, and adjustment. CMAR shall follow appropriate sequencing as recommended by manufacturer.
- B. Should manufacturer's instructions conflict with Contract Documents, CMAR shall request clarification from Engineer prior to proceeding.
- C. If required by individual product or equipment specification sections, CMAR shall submit manufacturer's printed instructions prior to assembly and installation.

1.11 MANUFACTURERS' CERTIFICATES

- A. Submit manufacturer's certificate indicating that equipment or products meet or exceed specified requirements where required in the individual specification sections.
- B. Certificates shall be submitted prior to shipment of equipment or products.

1.12 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment and other services as applicable, and to initiate instructions when necessary.
- B. Submit qualifications of observer to Engineer 30 days in advance of required observations. Observer subject to approval of Engineer.
- C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.
- D. Refer to Section 01 33 00.

1.13 QUALIFICATION TESTS

- A. Should a product, material, or method for assembly of unknown or questionable quality to the Engineer be proposed by the CMAR, additional tests may be required by the Engineer.

- B. Additional testing as required by the Engineer shall be used as a basis to establish acceptance or rejection.

1.14 LABORATORY TESTS

- A. Laboratory tests shall be conducted and test reports shall be submitted where this type of test is specified. All laboratory tests shall be made by an independent laboratory approved by the Engineer. These tests shall be performed in accordance with applicable ASTM standards.
- B. Laboratory tests may be witnessed by representatives of the Owner or Engineer.
- C. Submit two (2) copies of all laboratory tests to the Engineer for record.

1.15 PRODUCT FIELD TESTS

- A. Product field tests shall be set up and completed by the CMAR. CMAR shall provide all tools, equipment, instruments, personnel, and other facilities required for the completion of each test.
- B. Product field tests of process equipment, mechanical systems, electrical systems, piping systems, and similar facilities shall be conducted where this type of test is specified.
- C. Product field tests include the determination of performance, capacity, efficiency, function, tightness, leakage, and other special requirements. Product field tests shall be performed in accordance with applicable standards and test codes.
- D. Product field tests may be witnessed by representatives of Owner and Engineer.
- E. Submit two (2) copies of all product field tests to the Engineer for record.

1.16 MATERIALS FIELD TESTS

- A. Routine tests of materials incorporated into the Project will be performed by an independent testing laboratory arranged and paid for by the Owner and acceptable to the Engineer.
- B. Results of materials field testing shall be reported to the Engineer and CMAR.
- C. Material field tests may be witnessed by representatives of the CMAR, Owner, Engineer, and Engineer's subconsultant and such witnessing shall be paid for by the Owner.
- D. CMAR shall provide for at least two different certified gradation tests from each source of granular materials provided for the project site or one (1) sample from each 1,500 tons of finished product used. Certified gradation tests shall be done in accordance with ASTM C136 and be performed by the independent testing laboratory hired by the CMAR.

- E. CMAR shall provide at least two (2) different certified moisture-density relationship (compaction curve) tests from each source of materials provided to the project site. Certified moisture-density relationship tests shall be done in accordance with ASTM D698 and be performed by the independent testing laboratory hired by the CMAR.
- F. The following inspections and testing shall be conducted by the independent testing laboratory hired and paid for by the CMAR, except where noted, and accepted by the Engineer with results being reported to the CMAR and Engineer. See Statement of Special Inspection for additional requirements of building codes.

1. Excavating, Filling, and Grading Soil Compaction Testing:

Item	Requirement	Test Method	Frequency
Building or Structure Sites Floor Slabs	100 percent of ASTM D698 maximum dry density +/- 3% for sands.	ASTM D6938	One (1) approved test per 2,500 sf with a minimum of two (2) density tests that indicate soil bearing capacity as required per 8-inch lift.
Footings / Foundation Subgrade	100 percent of ASTM D698 maximum dry density +/- 3% for sands.	ASTM D6938	One (1) approved test per 50 lf with a minimum of two (2) approved density tests indicating soil bearing capacity as required per 8-inch lift.
Exterior Slabs	98 percent of ASTM D698 maximum dry density & + 4% to 0% optimum moisture content for clays and +/- 3% for sands.	ASTM D6938	One (1) approved test per 2,500 sf of an area with a minimum of two (2) density tests that indicate soil bearing capacity as required per 8-inch lift.
Structural Backfill	98 percent of ASTM D698 maximum dry	ASTM D6938	One (1) approved test per 50 lf with a minimum of two

Item	Requirement	Test Method	Frequency
	density & + 4% to 0% optimum moisture content for clays and +/- 3% for sands.		(2) approved density tests indicating soil bearing capacity as required per 8-inch lift.
Utility and Piping Trenches	98 percent of ASTM D698 maximum dry density.	ASTM D6938	One (1) approved test per 100 lf indicating soil bearing capacity as required per 24-inch lift.
Roadway Grading	98 percent of ASTM D698 maximum dry density & + 4% to 0% optimum moisture content for clays and +/- 3% for sands.	ASTM D6938	One (1) approved test per 2,000 cubic yards of embankment material.
Roadway Subgrade Preparation	98 percent of ASTM D698 maximum dry density & + 4% to 0% optimum moisture content for clays and +/- 3% for sands.	ASTM D6938	One (1) approved test per 200 lf of roadway and proof roll all areas subject to vehicle traffic.
Aggregate Base	98 percent of ASTM D698 maximum dry density.	ASTM D6938	One (1) approved test per 200 lf of roadway and proof roll all areas subject to vehicle traffic.
Parking Areas and Sidewalks	98 percent of ASTM D698 maximum dry density.	ASTM D6938	One (1) approved test per 3,000 sf of an area with a minimum of two (2) approved density tests that indicate soil bearing capacity as required per

Item	Requirement	Test Method	Frequency
			parking area or sidewalk section.
Landscaped Areas	90 percent of ASTM D698 maximum dry density.		

2. Excavating, Filling, and Grading Soil Material Testing:

Item	Parameter	Test Method	Frequency
Building / Structure / Roadway / Landscape Fill / Subgrade	Standard Proctor	ASTM D698	Two (2) per Source, by CONTRACTOR
Building / Structure / Roadway / Landscape Fill / Subgrade	Soil Classification	ASTM D2487	One (1) per 10,000 CY of Material, by CONTRACTOR
Building / Structure / Roadway / Landscape Fill / Subgrade	Sieve Analysis	ASTM C136	One (1) per 10,000 CY of Material, by CONTRACTOR
Building / Structure / Roadway / Landscape Fill / Subgrade	Liquid & Plastic Limits	ASTM D4318	One (1) per 10,000 CY of Material, by CONTRACTOR

3. Granular Materials Testing:

Item	Parameter	Test Method	Frequency
Structure Aggregate Base / Pipe Bedding Material / Road Aggregate Base	Sieve Analysis	ASTM C136	One (1) per 1,000 CY or 1,500 tons of Material, by CONTRACTOR

4. Concrete Specimens:

- a. Cast four (4) cylinders per set – one (1) at 7 days, two (2) at 28 days, and one (1) for 54 days.
- b. Cast one set of cylinders for five (5) cubic yards or larger per unit or structure. Cast an additional set of cylinders for each additional 75 cubic yards of cast-in-place concrete or masonry grout
- c. Cylinders (2 per set) shall be field cured.

- d. Standard tests to be performed on fresh concrete each time cylinders are cast are slump, air content, and temperature.
 - e. Concrete temperature shall be tested hourly, and recorded, when air temperature is 40 degrees Fahrenheit (4.44 degrees Celsius) and below, and when 80 degrees Fahrenheit (26.67 degrees Celsius) and above.
 - f. See Drawings for additional requirements.
- 5. Bituminous Specimens:
 - a. Obtain samples of placed bituminous prior to bituminous being rolled at the rate of one (1) sample per 100-ton of each mix placed per lift with a minimum of one (1) sample per mix per lift per day. CMAR shall cooperate with Engineer in obtaining the samples.
 - b. Perform testing for gradation and extraction on each sample.
- 6. All Structural Welding:
 - a. Visual observation at all connections.
 - b. Non-Destructive testing at full or partial penetration welds.
 - c. Weld Radiographs and Weld Inspection Report, including metal roof deck welding.
 - d. See Drawings or Code Required Special Inspections for additional requirements.
- 7. High Strength Bolting for Structural Steel
 - a. Visual observation at all connections.
 - b. Tension testing for ten (10) percent of all connections with a minimum of two (2) bolts per connection.
 - c. See Drawings or Code Required Special Inspections for additional requirements.
- 8. Masonry:
 - a. See Drawings or Code Required Special Inspections for additional requirements.

1.17 COATINGS FIELD TESTS

- A. An independent testing company hired by the CMAR may provide testing of coatings and coating systems. CMAR shall pay for testing of coatings and coating systems

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

- C. Examine and verify specific conditions described in individual specification sections.
- D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION 01 45 00

SECTION 01 45 16
CMAR QUALITY CONTROL

PART 1 - GENERAL

1.01 REFERENCES

- A. The following is a list of standards which may be referenced in this Section:
 - 1. ASTM International (ASTM):
 - 2. D3740, Evaluation of Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
 - 3. E329, Use in the Evaluation of Testing and Inspection Agencies as Used in Construction.
- B. Related Sections include:
 - 1. Section 01 33 00 - Submittal Procedures.
 - 2. Section 01 45 00 - Quality Control.
 - 3. Section 01 75 00 - Starting and Adjusting.

1.02 DEFINITIONS

- A. CMAR Quality Control (CQC): The means by which CMAR ensures that the construction, to include that performed by subcontractors and suppliers, complies with the requirements of the Contract.

1.03 SUBMITTALS

- A. CQC Plan: Submit, not later than 30 days after receipt of Notice to Proceed.
- B. CQC Report: Submit, weekly, an original and one copy in report form.

1.04 OWNER'S QUALITY ASSURANCE

- A. All Work is subject to Owner's quality assurance inspection and testing at all locations and at all reasonable times before acceptance to ensure strict compliance with the terms of the Contract Documents.
- B. Owner's quality assurance inspections and tests are for the sole benefit of Owner and do not:
 - 1. Relieve CMAR of responsibility for providing adequate quality control measures;
 - 2. Relieve CMAR of responsibility for damage to or loss of the material before acceptance;
 - 3. Constitute or imply acceptance; or

- 4. Affect the continuing rights of Owner after acceptance of the completed Work.
- C. The presence or absence of a quality assurance inspector does not relieve CMAR from any Contract requirement.
- D. Promptly furnish all facilities, labor, and material reasonably needed for performing such safe and convenient inspections and tests as may be required by Engineer.
- E. Owner may charge CMAR for any additional cost of inspection or test when Work is not ready at the time specified by CMAR for inspection or test, or when prior rejection makes re-inspection or retest necessary. Quality assurance inspections and tests will be performed in a manner that will not unnecessarily delay the Work.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 GENERAL

- A. Maintain an adequate inspection system and perform such inspections as will ensure that the Work conforms to the Contract Documents.
- B. Maintain complete inspection records and make them available at all times to Owner and Engineer.
- C. The quality control system shall consist of plans, procedures, and organization necessary to produce an end product that complies with the Contract Documents. The system shall cover all construction and demolition operations, both onsite and offsite, including Work by subcontractors, fabricators, suppliers and purchasing agents, and shall be keyed to the proposed construction sequence.

3.02 COORDINATION MEETING

- A. After the Preconstruction Conference, but before start of construction, and prior to acceptance of the CQC Plan, schedule a meeting with Engineer and Owner to discuss the quality control system.
- B. Develop a mutual understanding of the system details, including the forms for recording the CQC operations, control activities, testing, administration of the system for both onsite and offsite Work, and the interrelationship of CMAR's management and control with the Owner's Quality Assurance.

- C. There may be occasions when subsequent conferences may be called by either party to reconfirm mutual understandings and/or address deficiencies in the CQC system or procedures that may require corrective action by CMAR.

3.03 QUALITY CONTROL ORGANIZATION

A. CQC System Manager:

1. Designate an individual within CMAR's organization who will be responsible for overall management of CQC and have the authority to act in CQC matters for the CMAR.
2. CQC System Manager shall be an experienced construction person, with a minimum of 5 years construction experience on similar type Work.
3. CQC System Manager shall report to the CMAR's project manager or someone higher in the organization. Project manager in this context shall mean the individual with responsibility for the overall quality and production management of the Project.
4. CQC System Manager shall be onsite during construction; periods of absence may not exceed 2 weeks at any one time.
5. Identify an alternate for CQC System Manager to serve with full authority during the System Manager's absence. The requirements for the alternate will be the same as for designated CQC System Manager.

B. CQC Staff:

1. Designate a CQC staff, available at the Site at all times during progress, with complete authority to take any action necessary to ensure compliance with the Contract. CQC staff members shall be subject to acceptance by Engineer.
2. CQC staff shall take direction from CQC System Manager in matters pertaining to QC.
3. CQC staff must be of sufficient size to ensure adequate QC coverage of Work phases, work shifts, and work crews involved in the construction. These personnel may perform other duties, but must be fully qualified by experience and technical training to perform their assigned QC responsibilities and must be allowed sufficient time to carry out these responsibilities.
4. The actual strength of the CQC staff may vary during any specific Work period to cover the needs of the Project. Add additional staff when necessary for a proper CQC organization.

- C. Organizational Changes: Obtain Engineer's acceptance before replacing any member of the CQC staff. Requests for changes shall include name, qualifications, duties, and responsibilities of the proposed replacement.

3.04 QUALITY CONTROL PHASING

- A. CQC shall include at least three phases of control to be conducted by CQC System Manager for all definable features of Work, as follows:
1. Preparatory Phase:
 - a. Notify Owner at least 48 hours in advance of beginning any of the required action of the preparatory phase.
 - b. This phase shall include a meeting conducted by the CQC System Manager and attended by the superintendent, other CQC personnel (as applicable), and the foreman responsible for the definable feature. The CQC System Manager shall instruct applicable CQC staff as to the acceptable level of workmanship required in order to meet Contract requirements.
 - c. Document the results of the preparatory phase meeting by separate minutes prepared by the CQC System Manager and attached to the QC report.
 - d. Perform prior to beginning Work on each definable feature of Work:
 - 1) Review applicable Contract Specifications.
 - 2) Review applicable Contract Drawings.
 - 3) Verify that all materials and/or equipment have been tested, submitted, and approved.
 - 4) Verify that provisions have been made to provide required control inspection and testing.
 - 5) Examine the Work area to verify that all required preliminary Work has been completed and is in compliance with the Contract.
 - 6) Perform a physical examination of required materials, equipment, and sample Work to verify that they are on hand, conform to approved Shop Drawing or submitted data, and are properly stored.
 - 7) Review the appropriate activity hazard analysis to verify safety requirements are met.
 - 8) Review procedures for constructing the Work, including repetitive deficiencies.
 - 9) Document construction tolerances and workmanship standards for that phase of the Work.
 - 10) Check to verify that the plan for the Work to be performed, if so required, has been accepted by Engineer.
 2. Initial Phase:

- a. Accomplish at the beginning of a definable feature of Work:
 - 1) Notify Owner at least 48 hours in advance of beginning the initial phase.
 - 2) Perform prior to beginning Work on each definable feature of Work:
 - 3) Review minutes of the preparatory meeting.
 - 4) Check preliminary Work to verify compliance with Contract requirements.
 - 5) Verify required control inspection and testing.
 - 6) Establish level of workmanship and verify that it meets minimum acceptable workmanship standards. Comparison with sample panels is appropriate.
 - 7) Resolve all differences.
 - 8) Check safety to include compliance with and upgrading of the safety plan and activity hazard analysis. Review the activity analysis with each worker.
 - 9) The initial phase should be repeated for each new crew to work onsite, or any time acceptable specified quality standards are not being met.
- 3. Follow-up Phase:
 - a. Perform daily checks to verify continuing compliance with Contract requirements, including control testing, until completion of the particular feature of Work.
 - b. Daily checks shall be made a matter of record in the CQC documentation and shall document specific results of inspections for all features of Work for the day or shift.
 - c. Conduct final follow-up checks and correct all deficiencies prior to the start of additional features of Work that will be affected by the deficient Work. Constructing upon or concealing nonconforming Work will not be allowed.
- 4. Additional Preparatory and Initial Phases: Additional preparatory and initial phases may be conducted on the same definable features of Work as determined by Owner if the quality of ongoing Work is unacceptable; or if there are changes in the applicable QC staff or in the onsite production supervision or work crew; or if work on a definable feature is resumed after a substantial period of inactivity, or if other problems develop.

3.05 CMAR QUALITY CONTROL PLAN

A. General:

1. Plan shall identify personnel, procedures, control, instructions, test, records, and forms to be used.
2. An interim plan for the first 30 days of operation will be considered.
3. Construction will be permitted to begin only after acceptance of the CQC Plan or acceptance of an interim plan applicable to the particular feature of Work to be started.
4. Work outside of the features of Work included in an accepted interim plan will not be permitted to begin until acceptance of a CQC Plan or another interim plan containing the additional features of Work to be started.

B. Content:

1. Plan shall cover the intended CQC organization for the entire Contract and shall include the following, as a minimum:
 - a. Organization: Description of the quality control organization, including a chart showing lines of authority and acknowledgment that the CQC staff will implement the three-phase control system for all aspects of the Work specified.
 - b. CQC Staff: The name, qualifications, duties, responsibilities, and authorities of each person assigned a QC function.
 - c. Submittals: Procedures for scheduling, reviewing, certifying, and managing submittals, including those of subcontractors, offsite fabricators, suppliers and purchasing agents.
 - d. Testing: Control, verification and acceptance testing procedures for each specific test to include the test name, frequency, specification paragraph containing the test requirements, the personnel and laboratory responsible for each type of test, and an estimate of the number of tests required.
 - e. Procedures for tracking preparatory, initial, and follow-up control phases and control, verification, and acceptance tests, including documentation.
 - f. Procedures for tracking deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.
 - g. Reporting procedures, including proposed reporting formats; include a copy of the CQC report form.

C. Acceptance of Plans: Acceptance of the CMAR's basic and addendum CQC plans is required prior to the start of construction. Acceptance is conditional and will be predicated on satisfactory performance during the construction. Owner reserves the right to require CMAR to make changes in the CQC plan and operations including removal of personnel, as necessary, to obtain the quality specified.

- D. Notification of Changes: After acceptance of the CQC plan, CMAR shall notify Engineer, in writing, a minimum of 7 calendar days prior to any proposed change. Proposed changes are subject to acceptance by Engineer.

3.06 CONTRACTOR QUALITY CONTROL REPORT

- A. As a minimum, prepare a CQC report for every month. Include copies of test reports and copies of reports prepared by QC staff.
- B. Maintain current records of quality control operations, activities, and tests performed, including the Work of subcontractors and suppliers.
- C. Records shall be on an acceptable form and shall be a complete description of inspections, the results of inspections, daily activities, tests, and other items, including but not limited to the following:
 - 1. CMAR/subcontractor and their areas of responsibility.
 - 2. Operating plant/equipment with hours worked, idle, or down for repair.
 - 3. Work performed today, giving location, description, and by whom. When a network schedule is used, identify each phase of Work performed each day by activity number.
 - 4. Test and/or control activities performed with results and references to specifications/plan requirements. The control phase should be identified (Preparatory, Initial, Follow-up). List deficiencies noted along with corrective action.
 - 5. Material received with statement as to its acceptability and storage.
 - 6. Identify submittals reviewed, with Contract reference, by whom, and action taken.
 - 7. Offsite surveillance activities, including actions taken.
 - 8. Job safety evaluations stating what was checked, results, and instructions or corrective actions.
 - 9. List instructions given/received and conflicts in Drawings and/or Specifications.
 - 10. CMAR's verification statement.
 - 11. Indicate a description of trades working on the Project; the number of personnel working; weather conditions encountered; and any delays encountered.
 - 12. These records shall cover both conforming and deficient features and shall include a statement that equipment and materials incorporated in file work and workmanship comply with the Contract.

3.07 SUBMITTAL QUALITY CONTROL

- A. Submittals shall be as specified in Section 01 33 00 - Submittal Procedures.

- B. The CQC organization shall be responsible for certifying that all submittals are in compliance with the Contract requirements. Owner will furnish copies of test report forms upon request by CMAR. CMAR may use other forms as approved.

3.08 TESTING QUALITY CONTROL

A. Testing Procedure – See Section 01 45 00

1. Perform tests specified or required to verify that control measures are adequate to provide a product which conforms to Contract requirements. Procure services of a licensed testing laboratory. Perform the following activities and record the following data:
 - a. Verify testing procedures comply with contract requirements.
 - b. Verify facilities and testing equipment are available and comply with testing standards.
 - c. Check test instrument calibration data against certified standards.
 - d. Verify recording forms and test identification control number system, including all of the test documentation requirements, have been prepared.
 - e. Documentation:
 - 1) Record results of all tests taken, both passing and failing, on the CQC report for the date taken.
 - 2) Include specification paragraph reference, location where tests were taken, and the sequential control number identifying the test.
 - 3) Actual test reports may be submitted later, if approved by Engineer, with a reference to the test number and date taken.
 - 4) Provide directly to Engineer an information copy of tests performed by an offsite or commercial test facility. Test results shall be signed by an engineer registered in the state where the tests are performed.
 - 5) Failure to submit timely test reports, as stated, may result in nonpayment for related Work performed and disapproval of the test facility for this Contract.

3.09 COMPLETION INSPECTION

- A. CQC System Manager shall conduct an inspection of the Work at the completion of all Work or any milestone established by a completion time stated in the Contract.
- B. Punchlist:
 1. CQC System Manager shall develop a punchlist of items which do not conform to the Contract requirements.

2. Include punchlist in the CQC report, indicating the estimated date by which the deficiencies will be corrected.
3. CQC System Manager or staff shall make a second inspection to ascertain that all deficiencies have been corrected and so notify the Owner.
4. These inspections and any deficiency corrections required will be accomplished within the time stated for completion of the entire Work or any particular increment thereof if the Project is divided into increments by separate completion dates.

END OF SECTION 01 45 16

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SECTION 01 51 00
TEMPORARY UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Temporary Electricity.
2. Temporary Natural Gas.
3. Temporary Lighting.
4. Temporary Heating and Ventilation.
5. Fire Protection.
6. Temporary Telecommunications.
7. Temporary Water.

B. Related Sections include:

1. Section 01 10 00 – Summary of Work.
2. Section 01 11 13 - Work Covered by Contract Documents.
3. Section 01 11 16 - Work by Owner.
4. Section 01 52 00 - Construction Facilities.
5. Section 01 77 00 - Closeout Procedures.
6. Division 26.

1.02 TEMPORARY ELECTRICITY

- A. Provide and pay for power service required from utility source.
- B. Coordinate with requirements of Division 26.
- C. Provide temporary electric feeder from existing or new electrical service at all sites. Do not disrupt Owner's use of service.
- D. Provide separate metering or reimburse Owner for cost of energy used at existing service sites.
- E. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.
- F. Provide main service disconnect and over-current protection at convenient location.
- G. Permanent convenience receptacles may be utilized during construction.
- H. Provide adequate distribution equipment, wiring, and outlets to provide single-phase branch circuits for power and lighting.

- I. Pay for power required and used from utility source during construction operations
- J. Exercise measures to conserve power usage.

1.03 TEMPORARY NATURAL GAS

- A. There is currently no natural gas available at the Site. Montana Dakota Utilities (MDU) is the local gas provider.
- B. CMAR shall make arrangements with gas utility for natural gas required for construction, if required. CMAR shall provide temporary gas service, meter, and pay for gas used during construction operations as required by CMAR's construction operations.

1.04 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Refer to Division 26.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.
- D. Permanent building lighting may be utilized during construction. Replace lamps at final completion for all permanent fixtures.

1.05 TEMPORARY HEATING AND VENTILATION

- A. Provide and pay for heating devices and heat as needed to maintain specified conditions for construction operations.
 - 1. If required, provide separate metering or reimburse Owner for cost of energy used.
 - 2. Prior to operation of permanent equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.
 - 3. Maintain minimum ambient temperature of 50° F in areas, unless indicated otherwise in product sections.
 - 4. Exercise measures to minimize construction heating.
- B. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- C. Coordinate use of existing facilities with OWNER. CMAR shall extend and supplement with temporary units as required to meet construction requirements.

1.06 FIRE PROTECTION

- A. CMAR shall provide and maintain in working order throughout the entire construction period fire extinguishing equipment in each separate construction area. Fire extinguishing equipment shall be of adequate size, number, and capacity for the required areas in accordance with all applicable codes and satisfactory to the local Fire Marshal.
- B. Fire extinguishers shall be non-freeze type such as A-B-C rated dry chemical and be of the size and capacity required for each individual area.
- C. CMAR shall provide and maintain in working order fire extinguishing equipment within enclosed construction sheds and field offices.

1.07 TEMPORARY TELECOMMUNICATIONS

- A. Provide, maintain, and pay for telephone and high-speed internet service for field offices and cellular phone service for project superintendent from time of project mobilization to final completion as required.

1.08 TEMPORARY WATER SERVICE

- A. CMAR shall verify location of temporary water supply on or near site and shall provide piping, hoses, meter, and fittings required to distribute it as required by the Work.
- B. CMAR shall pay for all water used for construction purposes prior to final completion.
- C. CMAR shall not damage plumbing at source of temporary water.
- D. Where water source is not available at or near site, CMAR shall make arrangements with OWNER for source of water at appropriate hydrant locations. CMAR shall provide tanker truck, and metering equipment necessary to measure water from hydrant locations.

1.09 REMOVAL OF TEMPORARY UTILITIES

- A. Remove temporary utilities, equipment, and materials, prior to Final Application for Payment inspection.
- B. Remove underground installations as required. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 51 00

SECTION 01 52 00
CONSTRUCTION FACILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Field Offices and Sheds.
2. First Aid Facilities.
3. Sanitary Facilities.
4. Temporary Housing.
5. Removal of Construction Facilities.

B. Related Sections include:

1. Section 01 11 13 - Work Covered by Contract Documents.
2. Section 01 11 16 - Work by Owner.
3. Section 01 51 00 - Temporary Utilities.
4. Section 01 55 29 - Staging Areas.
5. Section 01 77 00 - Closeout Procedures.

1.02 FIELD OFFICES AND SHEDS

- A. CMAR shall provide and maintain a field office for use by the ENGINEER during construction. The field office shall be a minimum of 9 ½ feet wide with 7 foot (213.36 cm) ceilings. A minimum of 320 sq feet (0.34446 sq cm) of usable space shall be provided divided into an office at one end and an open area at the other. The open area shall have a table suitable for meetings. Appropriate furnishings shall be provided for the office area including a desk and chair, drafting table and stool, wastebasket, shelves, file cabinets, printer/scanner, and plan rack. CMAR shall provide a phone and high-speed internet access capable of 10 Mbps.
- B. CMAR shall provide and maintain a field office with a conference table for project meetings during construction. The field office and conference table shall be of suitable size for conducting meetings including CMAR, Contractors, Subcontractor, Owner, and Engineer personnel. At least one copy of the contract documents, specifications, drawings and approved shop drawings shall be kept at the CMAR's field office available for use at any time. Provide a projector and screen or a large flat screen monitor for connection of a computer for viewing project documents.
- C. Field offices shall be weatherproof and insulated with finished interior walls, ceilings, and floors.

- D. Windows and doors shall be provided for each area. Adequate lighting and electrical service shall be provided.
- E. Heating and cooling systems shall be provided capable of maintaining a temperature of 75 degrees Fahrenheit (23.89 degrees Celsius).
- F. Construction trailers or sheds: At CMAR's option. Coordinate locations with Owner.
- G. Locate Field Offices and construction trailer or shed a minimum distance of 30 feet (914.4 cm) from existing and new structures. Owner's approval of location is required.
- H. CMAR is responsible for Temporary Utilities to feed Construction Facilities.

1.03 TEMPORARY SANITARY FACILITIES

- A. CMAR shall provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide from time of project mobilization to final completion.
- B. Connection to existing sanitary sewer is permitted. CMAR shall provide facilities necessary to provide connection.

1.04 FIRST AID FACILITIES

- A. First aid facilities shall be provided and maintained by the CMAR in accordance with all federal, state, and local laws and regulations.

1.05 TEMPORARY HOUSING

- A. Owner will not allow temporary housing on-site.

1.06 REMOVAL OF CONSTRUCTION FACILITIES

- A. Remove temporary utilities, equipment, facilities, and materials, prior to Final Application for Payment inspection.
- B. Remove underground installations as required. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 52 00

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SECTION 01 54 00
CONSTRUCTION AIDS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Construction Aids.
 - 2. Protection of Installed Work.
 - 3. Temporary Construction Protection.

1.02 GENERAL

- A. Provide and maintain required construction aids, remove upon completion of work.
- B. Modify or remove as required to accommodate each construction phase and as independent components of project are completed.
- C. Comply with all Federal, State, and Local codes and regulations.
- D. Nothing in the specification shall be interpreted as contrary to minimum safety requirements of OSHA and other regulatory authorities. In case of conflict the strictest regulation shall govern. CMAR shall provide the appropriate design of construction aids to facilitate work and meet the actual required conditions for the work.

1.03 CONSTRUCTION AIDS

- A. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work: scaffolds, staging, shoring and bracing, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes, and other such facilities and equipment.
- B. Maintain all facilities and equipment in an operable, clean and fully functional condition.
- C. Store and protect construction aids when not in direct use for the Work.

1.04 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to prevent damage.

- C. Provide protective coverings at pipe openings, manholes, and all structures.
- D. Protect roadways, access drives, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects.
- E. Prohibit traffic or storage upon finished subgrade or areas with restored topsoil surfaces.
- F. Prohibit traffic from landscaped areas.

1.05 TEMPORARY CONSTRUCTION PROTECTION

- A. CMAR shall provide and maintain temporary supports, shoring, and bracing as required for protection of work.
- B. CMAR shall assure the adequacy of all temporary shoring and bracing.
- C. Repair or replace damaged work occasioned by inadequate temporary supports, shoring, or bracing.
- D. Leave temporary supports, shoring, and bracing in place until permanent construction is complete to point where installed work is properly supported.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 54 00

SECTION 01 55 00
VEHICULAR ACCESS AND PARKING AREAS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Parking.
 - 2. Temporary Access Roads.
 - 3. Traffic Control.
 - 4. Entrance Road.
 - 5. Haul Routes.

1.02 PARKING

- A. CMAR and personnel shall park all personal vehicles in an area acceptable to Owner and applicable property owners.
- B. CMAR shall provide and maintain a surface suitable for parking vehicles.

1.03 ACCESS ROADS

- A. Maintain access roads leading into Site and parking areas.
- B. Provide means of removing mud from vehicle wheels before entering streets and roads.
- C. Construct and maintain temporary roads accessing public roads to serve construction areas.
- D. Temporary construction entrances shall be constructed as indicated in the specifications or contract drawings.

1.04 TRAFFIC CONTROL

- A. CMAR shall maintain two-way traffic at all times on impacted roadways.
- B. CMAR shall provide and maintain signs, warning lights, and barricades to adequately protect warn and protect the public from hazardous protrusions, materials, excavations, and equipment resulting directly or indirectly from construction activities.
- C. All traffic control devices including signs, warning lights, and barricades shall conform to the requirements of the Manual on Uniform Traffic Control Devices.

- D. Traffic control setup and layout shall conform to requirements of the manual for Traffic Control Zone Layouts (field manual) and shall be the sole responsibility of the CMAR.
- E. CMAR shall give Owner and Engineer at least 48 hours notice prior to a partial blockage or closure of any street or public right of way. When working in the right of way of county roads, CMAR shall be responsible for acquiring the necessary permits for working in a right-of-way.
- F. Traffic control devices shall be inspected daily. Warning lights should be checked for proper operation and cleaned as required. All broken or ineffective traffic control devices shall be replaced immediately.
- G. CMAR shall designate an individual and one alternate to have responsible charge of proper installation and maintenance of the traffic control devices. These individuals shall be available on a 24-hour on call basis.

1.05 ENTRANCE ROAD

- A. Not Used.

1.06 HAUL ROUTES

- A. The CMAR shall take whatever steps are necessary to ensure that no overloading is done and road restrictions are followed by all suppliers and Sub-contractors. This will insure that no city, county, state or other restrictions are violated. It shall be the responsibility of the CMAR to familiarize himself with all local regulations before starting construction. Any road damaged by the CMAR shall be repaired to the original condition at the CMAR's expense, to the satisfaction of the Engineer.

1.07 REMOVAL OF ACCESS FACILITIES

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

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 55 00

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SECTION 01 55 29
STAGING AREAS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Staging Areas.
 - 2. Stockpile Areas

1.02 STAGING AREAS

- A. Maintain access to Black Hills Energy substation at all times.
- B. CMAR shall coordinate and utilize only areas within the construction limits for construction facilities, storage of materials and equipment, parking, and staging operations.
- C. The areas and grounds utilized shall be left clean and restored to original condition.
- D. CMAR shall be responsible for coordination of construction, staging, and temporary stockpile activities with Owner.

1.03 STOCKPILE AREAS

- A. Maintain access to Black Hills Energy substation at all times.
- B. CMAR shall stockpile excess material from excavations in locations acceptable to Owner.
- C. CMAR shall make arrangements to stockpile materials within areas of the Construction limits.
- D. CMAR shall coordinate construction, staging, and stockpile activities and Owner shall not be responsible for any additional charges due to moving of staging and/or stockpile materials multiple times.
- E. Temporary and final stockpiles shall be maintained during construction and protected from erosion.
- F. The areas and grounds utilized shall be left clean and restored to original condition.

1.04 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification sections.
- B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to prevent damage.
- C. Prohibit traffic from landscaped areas.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 55 29

SECTION 01 56 00
TEMPORARY BARRIERS AND ENCLOSURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Temporary Fencing.
 - 2. Temporary Barriers.
 - 3. Temporary Enclosures.
 - 4. Temporary Construction Protection.
 - 5. Security.

1.02 TEMPORARY FENCING

- A. Provide fencing around open excavation areas.

1.03 TEMPORARY BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas, to allow for Owner's use of site, and to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide protection for plants designated to remain. Replace damaged plants.
- C. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.04 TEMPORARY ENCLOSURES

- A. Not Used.

1.05 TEMPORARY CONSTRUCTION PROTECTION

- A. Shoring and Bracing:
 - 1. CMAR shall provide and maintain temporary supports, shoring, and bracing as required for safety and protection of work.
 - 2. CMAR shall assure the adequacy of all temporary shoring and bracing.
 - 3. Repair or replace damaged work occasioned by inadequate temporary supports, shoring, or bracing.
 - 4. Leave temporary supports, shoring, and bracing in place until permanent construction is complete to point where installed work is properly supported.

1.06 SECURITY

- A. Provide security and facilities to protect Work, and existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.
- B. Upon completion of this Work, CMAR shall ensure doors and gates are locked and secure. No claims shall be made against Engineer or Owner for any act of an employee or trespasser, and CMAR shall make good on any damage to Owner's property, resulting from CMAR's failure to provide sufficient security in the absence of the Engineer and Owner.
- C. CMAR to discuss security with employees and subcontractors and advise them to immediately report anything suspicious which could be a security issue.

1.07 REMOVAL OF TEMPORARY BARRIERS AND ENCLOSURES

- A. Remove temporary barriers and enclosures, prior to Final Application for Payment inspection.
- B. Remove underground installations as required. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 56 00

SECTION 01 57 00
TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Temporary Erosion and Sediment Control.
2. Storm Water Pollution Control.
3. Environmental Control
4. Tree Protection.

1.02 TEMPORARY EROSION AND SEDIMENT CONTROL

A. Storm Water Permits

1. CMAR shall obtain all necessary permits from Watershed Districts or responsible regulatory agencies for temporary erosion control measures. CMAR shall obtain an NPDES storm water permit for construction disturbing more than one acre of area in conjunction with the Owner.
2. CMAR shall provide and maintain all best management practices necessary for erosion prevention, sediment control, dewatering and basin draining, and pollution prevention management measures at the Site in accordance with the requirements of the NPDES Storm Water permit and associated storm water pollution prevention plan (SWPPP) or erosion control plan to be submitted to the DANR following award of the contract and prior to beginning construction.
3. The following paragraphs outline general best management practices that will be included in the SWPPP submitted to the DANR prior to construction. The SWPPP and NPDES shall be located at the site at all times during the construction. CMAR shall meet the general requirements as outlined below and any additional requirements required as a part of the review and approval of the NPDES storm water permit and SWPPP.

B. Erosion Prevention Practices:

1. CMAR shall schedule construction activities and conduct operations so as to minimize erosion of soils.
2. CMAR shall phase construction activities to minimize the amount of disturbed areas at one time. Provide temporary seeding, vegetative buffer strips, mulch or wood fiber blanket, and/or sod stabilization in disturbed areas not being actively worked and not yet ready for final

grading and stabilization. The permit limits the amount of time soils can remain unstabilized:

- a. Slopes steeper than 3:1 – within 7 days.
 - b. Slopes from 10:1 to 3:1 – within 14 days.
 - c. Slopes flatter than 10:1 – within 21 days.
3. Temporary sediment control basins may also be necessary for steep slope areas or high erodible soils. CMAR shall construct temporary sediment control basins as necessary to meet additional requirements following review and approval of the NPDES storm water permit and associated SWPPP.

C. Sediment Control Practices:

1. Provide temporary measures such as silt fencing, berms, dikes, and turf establishment to prevent erosion. Construct drainage facilities and turf establishment concurrently with earthwork operations.
2. Incorporate erosion control measures at the earliest practical time during construction. Provide erosion control measures as directed prior to the disturbance of in-place ground cover in critical areas which area tributary to public waters.
3. CMAR shall maintain all temporary erosion control measures throughout the duration of the project and remove them upon completion of permanent erosion control measures and turf establishment.
4. Protect all existing and new storm drain inlets.
5. Control temporary soil stockpiles.
6. Control vehicle tracking with stone pads, concrete, steel wash racks, or equivalent.
7. Provide gravel construction entrances at field entrances to the Site.
8. Remove sediment tracked onto streets within 24 hours of detection.

D. Inspections and Maintenance of SWPPP:

1. Shall be conducted by Owner, CMAR, or designee.
2. Occur every seven (7) days.
3. Occur within twenty-four (24) hours of ½" storm.
4. Be routinely recorded and kept with the SWPPP.
5. Occur once a month on final stabilized area.
6. Ensure integrity and effectiveness of erosion prevention and sediment control measures.
7. Repair or replace nonfunctional best management practices or erosion control measures.
8. Drain and remove sediment from basins.
9. Inspect surface waters, drainage ditches and conveyance systems for sediment.
10. Remove sediment deposits and stabilize any exposed soil during sediment removal.

11. Inspect and clean vehicle exits.
12. Ensure infiltration areas are protected.

1.03 STORM WATER POLLUTION CONTROL

- A. The minimum requirements are set forth by the South Dakota Department of Agriculture and Natural Resources. They insure that minimal environmental degradation occurs as a result of construction or related work which has the potential to affect the waters of the State of South Dakota. All activities will be designed and implemented to restrict the losses or disturbances of soil, vegetative cover, and pollutants (chemical, physical, or biological) from the Site.
- B. Pollution Prevention Management Measures:
 1. CMAR shall provide proper collection and disposal of solid waste. All construction debris and solid waste shall be contained in dumpsters or roll off boxes. All dumpsters and roll off boxes shall be located behind erosion control devices and a minimum of ten (10) feet from any catch basin structure.
 2. All construction material shall be stored in an orderly manner.
 3. All chemicals on site shall be kept in sealed containers with their original labeling and Material Safety Data sheets available.
 4. All appropriate agencies shall be notified of any spill of fuel, oil, or other hazardous chemicals immediately upon detection.
 5. Establish a specific truck washing site.
 6. There shall be no on site engine degreasing.
- C. Protection of Surface Waters:
 1. All construction which directly or indirectly impacts on aquatic systems will be managed to minimize impacts. All attempts will be made to prevent the contamination of water at construction sites from fuel spillage, lubricants, and chemicals, by following safe storage and handling procedures. Stream bank and stream bed erosion and disturbances will be controlled to minimize and/or prevent silt movement, nutrient upsurges, plant dislocation, and any physical, chemical, or biological disruption. The use of pesticides or herbicides in or near these systems is forbidden without approval from the appropriate governing agency.

1.04 ENVIRONMENTAL CONTROL

- A. Dust Control:
 1. CMAR shall be responsible for dust control throughout the duration of the Project.
 2. Work shall be executed by methods to minimize raising dust from construction operations.

3. Provide appropriate dust control measures as required to prevent excessive dust from dispersing into the air.
4. The use of petroleum products is prohibited.

B. Noise Control:

1. CMAR shall be responsible for noise control throughout the duration of the Project.
2. Avoid the use of tools and equipment, which produce harmful noise. Provide personal hearing protection devices as necessary for CMAR's and Owner's personnel.
3. Restrict the use of noise making tools and equipment to required hours of construction, if required by Owner or Drawings.

1.05 PROGRESS CLEANING AND WASTE REMOVAL

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum daily and mop weekly. Clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust. If Owner is not satisfied with CMAR's cleaning efforts, Owner reserves the right to charge Liquidated Damages for charges from a 3rd Party to appropriately clean the facilities.
- D. Collect and remove waste materials, debris, and rubbish from site weekly and dispose off-site.
- E. CMAR shall maintain site clean and free of obstructions that may cause injuries or otherwise prevent staff (Owner, Engineer, CMAR, etc....) from performing their job effectively.

1.06 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, and materials, prior to Final Application for Payment inspection.
- B. Remove underground installations as required. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing and permanent facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 57 00

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SECTION 01 58 00
PROJECT IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Project Identification.

B. Related Sections include:

1. Section 01 11 13 - Work Covered by Contract Documents.
2. Section 01 11 16 - Work by Owner.
3. Section 01 77 00 - Closeout Procedures.

1.02 PROJECT IDENTIFICATION

A. Project Sign

1. 8 feet wide by 4 feet high.
2. Exterior grade plywood and wood frame construction.
3. Painted with die cut vinyl, self-adhesive letters and self-adhesive corporate logo, to Engineer's design and colors.
4. Include the following information:
 - a. Project Name
 - b. Owner
 - c. Engineer
 - d. CMAR
 - e. Funding Agency
5. Erect on-site at location established by Engineer and Owner.
6. No other signs are allowed except those required by law.

B. Remove sign following completion of the Work.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 58 00

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SECTION 01 61 00
COMMON PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes:
 - 1. Products.
 - 2. Transportation and Handling.
 - 3. Storage and Protection.
 - 4. Product Options.
 - 5. Substitutions.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 45 00 - Quality Control .

1.02 PRODUCTS

- A. Products: Means new material, machinery, components, equipment, fixtures, and systems forming the Work. Does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work. Products may also include existing materials or components designated for re-use.
- B. All products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each product.
- C. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- D. Provide interchangeable components of the same manufacturer for components being replaced.
- E. Equipment covered by Division 26 shall be listed by UL, or by a nationally recognized third party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of the CMAR. If no third-party testing laboratory provides the required listing, an independent test shall be performed at CMAR's expense. Before the test is conducted, CMAR shall submit a copy of the testing procedure to be used.
- F. Premium and High Efficiency Products

1. The City of Hill City participates in various rebate programs to promote installation of high and premium efficiency equipment and products. The CMAR shall supply the necessary information for the Owner to complete the rebate forms.
2. Premium and High Efficiency Products shall be as specified in their associated technical specifications.

1.03 TRANSPORTATION AND HANDLING

- A. Transport and handle Products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.
- C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.04 STORAGE AND PROTECTION

- A. Store and protect Products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive Products in weather tight, climate controlled, enclosures in an environment favorable to Product.
- D. For exterior storage of fabricated Products, place on sloped supports above ground.
- E. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of Products.
- G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.
- J. CMAR shall be responsible to arrange for, receive, inspect, and unload all shipments of materials or equipment. CMAR shall provide haul route information to shipping companies.

1.05 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with an option for an "Or Equal" or "Approved Equivalent" or "Prior Approved Equivalent" Manufacturer: Submit a request for the "or equal/approved equivalent" in accordance with the following substitutions article. Requests and Engineer's acceptance of "Or Equal" or "Approved Equal" or "Prior Approved Equivalent" Manufacturers is allowed during bidding only.

1.06 SUBSTITUTIONS

- A. "Equal" or "Approved Equivalent" or "Acceptable" or "Prior Approved Equivalent" products will be considered only if written request is made at least 14 days prior to Bid opening.
- B. Substitutions will be considered when a Product becomes unavailable through no fault of the CMAR.
- C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- D. A request constitutes a representation that the Bidder: CMAR:
 - 1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
 - 2. Will provide the same warranty for the Substitution as for the specified Product.
 - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
 - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 - 5. Will reimburse Owner and Engineer for redesign services associated with re-approval by authorities.
- E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- F. Substitution Submittal Procedure:
 - 1. Submit two copies of request for consideration. Limit each request to one proposed Substitution.

2. Submit shop drawings, product data, and certified test results attesting to the proposed Product equivalence. Burden of proof is on proposer.
3. Fully identify the substitutions effects on all facets of the Work and construction schedule.
4. The Engineer will notify CMAR in writing of decision to accept or reject request.
5. Accepted substitutions will be listed by addendum.

PART 2 - PRODUCTS

2.01 UNIFORMITY

- A. For any type of similar equipment, i.e., motors, drive units, etc., provide equipment of the same manufacturer.
- B. Inform all subcontractors and suppliers of the selected manufacturers to ensure equipment uniformity.
- C. Obtain each separate type of product from the same manufacturer.

2.02 TOOLS

- A. For any equipment or equipment components requiring special tools, the CMAR shall supply the Owner with such tools to allow for the maintenance and removal/replacement of equipment components.

2.03 CONSUMABLES

- A. Provide Owner with all consumable items that are required during start-up and initial operation (90 days minimum) of all Project components including, but not limited to; coolant, fluids, oil, grease, other lubricants, filters, bulbs, batteries, etc.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment in full compliance with the manufacturer's recommendations.
- B. Obtain services of qualified and approved factory representatives to install, check, and approve the installation of all equipment.
- C. Service representative:
 1. Present for the start-up and initial operation of all equipment.
 2. Certify in writing that:
 - a. Equipment is properly installed and ready for operation.
 - b. Equipment properly aligned.
 - c. Direction of rotation checked.
 - d. Lubrication is proper.

- e. Unit is free from undue stress from connecting pipe or anchorage.
- f. Unit has operated at full load conditions.
- g. Unit has operated in full compliance with the project specifications and the manufacturer's recommendations.

END OF SECTION 01 61 00

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SECTION 01 65 00
PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Products.
 - 2. Preparation for Shipment.
 - 3. Transportation and Handling.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 33 00 - Submittal Procedures.

1.02 PRODUCTS

- A. Products: Means goods of new material, machinery, components, equipment, fixtures, and systems. Does not include machinery and equipment used for preparation, fabrication, conveying, and erection of the Work.
- B. All products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each product.
- C. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- D. Provide interchangeable components of the same manufacturer for components being replaced.

1.03 PREPARATION FOR SHIPMENT

- A. Prior to packaging equipment, Supplier shall provide packing list along with estimated package dimensions – Length x Width x Height (L x W x H) – for each package exceeding a 3-foot dimension in L, W, or H to Buyer. All Goods to be installed shall be shipped to the Point of Destination, freight paid by Supplier.
- B. All equipment shall be suitably packaged by Supplier to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

- C. Painted and coated surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted and coated surfaces which are damaged prior to final acceptance of equipment shall be repainted to the satisfaction of Buyer.
- D. Grease and lubricating oil shall be applied to all bearings and similar items.
- E. Delivery schedule for shipment of products shall be established by the Installation Contractor. Supplier shall coordinate delivery schedule with installation contractor accordingly.

1.04 TRANSPORTATION AND HANDLING

- A. Before shipping each item of equipment shall be tagged or marked by Supplier as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of equipment shall be included with each shipment.
- B. Transport and handle Products in accordance with manufacturers' instructions.
- C. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.
- D. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.
- E. Supplier shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the Point of Destination. Supplier shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the Goods specified in this Contract. These requirements also apply to any Sub-Suppliers making direct shipments to the Point of Destination.
- F. Delivery of portions of the equipment in several individual shipments shall be subject to review of Buyer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation, and to facilitate eventual installation.

PART 2 - PRODUCTS

2.01 UNIFORMITY

- A. For any type of similar equipment, i.e., motors, drive units, etc., provide equipment of the same manufacturer.
- B. Inform all Subcontractors and Suppliers of the selected manufacturers to ensure equipment uniformity.

2.02 TOOLS

- A. For any equipment or equipment components furnished requiring special tools, Supplier shall provide the special tools to the Installation Contractor. Installation Contractor shall supply the Owner with these tools to allow for the maintenance and removal/replacement of equipment components.
- B. Each submersible pump, mixer, and other equipment (excluding diffusers) which require periodic removal from their submerged state shall be supplied with their own davit arm and sleeve.

2.03 CONSUMABLES

- A. Provide Buyer with all consumable items that are required during start-up and initial operation (90 days minimum).

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 65 00

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SECTION 01 73 29
CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes:

1. Requirements and limitations for cutting and patching of Work.

B. Related Sections include:

1. Section 01 10 00 – Summary of Work.
2. Section 01 11 13 - Work Covered by Contract Documents.
3. Section 01 11 16 - Work by Owner.
4. Section 01 33 00 - Submittal Procedures.
5. Section 01 61 00 - Common Product Requirements.
6. Individual Product Specification Sections:
 - a. Cutting and patching incidental to Work of this Section.
 - b. Advance notification to other Sections of openings required in Work of those Sections.

1.02 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 element.
3. Efficiency, maintenance, or safety of any operational element.
4. Visual qualities of sight exposed elements.
5. Work of Owner or separate contractor(s).

B. Include in request:

1. Identification of Project.
2. Location and description of affected Work.
3. Necessity for cutting or alteration.
4. Description of proposed Work and Products to be used.
5. Alternatives to cutting and patching.
6. Effect on work of Owner or separate contractor(s).
7. Written permission of affected separate contractor(s).
8. Date and time Work will be executed.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Those required for original installation.
- B. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 61 00 - Common Product Requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.
- B. After uncovering existing Work, assess conditions affecting performance of Work.
- C. Understand and become familiar with required coating systems, application requirements, and spatial concerns, issues, and dimensions required to perform the Work.
- D. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Provide temporary supports to ensure structural integrity of the Work. Provide devices and methods to protect other portions of Project from damage.
- B. Provide protection from elements for areas that may be exposed by uncovering Work.
- C. Maintain excavations free of water.
- D. Verify that all materials are clean and free from defects.

3.03 CUTTING

- A. Execute cutting and fitting to complete the Work.
- B. Uncover work to install improperly sequenced Work.
- C. Remove and replace defective or non-conforming Work.
- D. Remove samples of installed Work for testing, when requested.
- E. Coordinate openings in the Work for penetration of process, mechanical and electrical Work.
- F. Employ original installer of new Work to perform cutting for weather exposed and moisture resistant elements, and sight-exposed surfaces. Employ experienced personnel or original supplier for applying specialized coating systems.

- G. Cut rigid materials, masonry, prestressed concrete, and concrete using masonry saw or core drill. Pneumatic tools not allowed without prior approval. Protect finished water reservoirs from materials produced during saw cutting and core drilling.

3.04 PATCHING

- A. Execute patching to complement adjacent Work.
- B. Fit Products together to integrate with other Work.
- C. Execute Work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.
- D. Employ original installer of new Work to perform patching for weather and moisture resistant elements, and sight-exposed surfaces.
- E. Restore Work with new Products in accordance with requirements of Contract Documents.
- F. Fit Work airtight and water tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- G. Maintain integrity of wall, ceiling, or floor construction; completely seal voids.
- H. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
- I. Identify any hazardous substance or condition exposed during the Work to the Architect/Engineer for decision or remedy.

3.05 ALTERATION PROJECT PROCEDURES

- A. Materials: As specified in Product sections; match existing Products and Work for patching and extending Work.
- B. Employ skilled and experienced installer to perform alteration Work.
- C. Close openings in exterior surfaces to protect existing Work from weather and extremes of temperature and humidity.
- D. Remove, cut, and patch Work in a manner to minimize damage and to provide means of restoring Products and finishes to original or specified condition.
- E. Refinish existing visible surfaces to remain in renovated rooms and spaces, to renewed condition for each material, with a neat transition to adjacent finishes.

- F. Where new Work abuts or aligns with existing, provide a smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.
- G. When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and submit recommendation to Engineer for review.
- H. Where a change of plane of 1/4 inch or more occurs, submit recommendation for providing a smooth transition; to Engineer for review request instructions from Engineer.
- I. Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing other imperfections.
- J. Finish surfaces as specified in individual Product Sections.

END OF SECTION 01 73 29

SECTION 01 75 00
STARTING AND ADJUSTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Quality Assurance.
2. Scheduling.
3. Preparation.
4. Starting Systems.
5. Start-Up Period.
6. Adjusting.
7. Acceptance of Equipment and Systems.
8. Guarantee and/or Warranty Period.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures.
2. Section 01 45 00 - Quality Control.
3. Section 01 77 00 - Closeout Procedures.
4. Section 01 78 23 - Operation and Maintenance Data.
5. Section 01 79 00 - Classroom Demonstration and Training.

1.02 QUALITY ASSURANCE

- A. Provide authorized and qualified manufacturer's representative to inspect, check, and approve equipment installation prior to start-up and to assist with demonstration testing.
- B. Authorized representative shall supervise placing equipment into operation.
- C. Prior to demonstration to Owner and Engineer, provide written confirmation that systems have been tested, adjustments have been made, and equipment is ready for start-up demonstration.
- D. Provide access to equipment and systems. Operate systems at designated times and under conditions required.
- E. CMAR shall submit four (4) copies of written start-up report for each system or equipment item following each start-up.

1.03 SCHEDULING

- A. CMAR shall submit four (4) copies of preliminary start-up, and instruction schedule at least 15 calendar days prior to proposed dates. List times and dates

for each system or equipment item. Include names of CMAR's and subcontractors personnel, manufacturer, and/or authorized representative proposed to perform services. Provide documentation to verify their qualifications.

- B. CMAR shall coordinate scheduling of start-up. Scheduling of start-up shall be subject to approval of Owner and Engineer.
- C. CMAR shall notify Owner and Engineer of changes in scheduling at least five (5) days in advance prior to scheduled start-up of individual systems or equipment. Scheduling changes shall be subject to approval by Owner and Engineer.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Confirm wiring to motors and controls are operational.
- B. Inspect equipment for cleanliness and remove or clean foreign matter.
- C. Lubricate each piece of equipment according to manufacturer's instructions. Check alignment, drive rotation, equipment speed, control sequence, and other conditions which may cause damage. Provide adjustment as required.
- D. Confirm that equipment is properly anchored and supported.
- E. Confirm wiring to motors and controls are operational.
- F. Confirm that auxiliary systems such as seal water and spray water systems are operational.
- G. Confirm that tests, meter readings, and specific electrical characteristics, including motor amperage agree with those specified.
- H. Confirm that control system is operation in automatic mode.
- I. Inspect hand and automatic valves, clean bonnets and stems, tighten packing glands to ensure no leakage. Adjust valves as necessary for proper operation. Verify valve proper valve positioning for prior to start-up and testing of associated equipment.
- J. Provide instruments required for testing, adjusting, and balancing operations.
- K. All costs associated with starting, testing, adjusting, and balancing equipment including power and fuel costs shall be responsibility of the CMAR.

3.02 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Engineer and Owner seven (7) days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, control sequence, and for conditions that may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable manufacturer's representative in accordance with manufacturer's instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.
- H. Submit a written report in accordance with Section 01 33 00 that equipment or system has been properly installed and is functioning correctly.

3.03 START-UP PERIOD

- A. Following successful completion of demonstration testing per Section 01 79 00 - Classroom Demonstration and Training, the CMAR shall be responsible for the operation and control of new equipment and/or systems for a minimum period of 15 days.
- B. CMAR shall be responsible for making any changes, repairs, or replacements during this 15 day operating period.
- C. During the 15 day testing period, the CMAR shall provide supervisory personnel who fully understand the operation of the equipment. It is the intention that during this period, the Owner's personnel will become familiar with the operation and maintenance of the equipment or system.
- D. All costs associated with operating and maintaining the installed equipment and/or systems, including power and fuel costs shall be the responsibility of the CMAR.

3.04 ADJUSTING

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

3.05 ACCEPTANCE OF EQUIPMENT AND SYSTEMS

- A. Upon completion of training specified in Section 01 79 00 - Classroom Demonstration and Training, receipt of the final operation and maintenance manuals per Section 01 78 23 - Operation and Maintenance Data, receipt of the required start-up and demonstration testing reports, and following successful completion of the 15 day operating period, ENGINEER shall promptly review submittals of the manuals and reports.
- B. CMAR shall provide additional information or tests if required by the Engineer.
- C. Following review of the information, Engineer shall recommend approval of the equipment and acceptance of the installation to the Owner. The Owner shall provide in writing notice of acceptance of the equipment within a reasonable time after receipt of Engineer's recommendation.
- D. Equipment placed into temporary operation prior to final completion of the project shall be readjusted and/or calibrated as required prior to final completion of the project.
- E. After equipment has been tested, adjusted, and accepted in writing by the Owner, but before final acceptance of the entire project, the Owner will assume operation and maintenance responsibilities for the equipment or systems, including power and fuel costs. The Owner may place portions of the facility into operation prior to final acceptance of the entire project.

3.06 GUARANTEE AND/OR WARRANTY PERIOD

- A. The guarantee or warranty period for all equipment and/or systems will start from the date of written notice of final acceptance of the equipment and/or systems by the Owner.
- B. There will be no exceptions to the start of the guarantee or warranty period.

END OF SECTION 01 75 00

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Closeout Procedures.
2. Substantial Completion.
3. Final Completion.
4. Final Cleaning.
5. Project Record Documents.
6. Spare parts and Maintenance Products.
7. Warranties and Bonds.
8. Maintenance Service.
9. Final Adjustment of Accounts.

B. Related Sections include:

1. Section 01 31 13 - Project Coordination.
2. Section 01 75 00 - Starting and Adjusting.
3. Section 01 78 23 - Operation and Maintenance Data.

1.02 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.
- B. Provide submittals to Engineer that are required by governing or other authorities.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due.
- D. Owner will occupy all portions of the Project.

1.03 SUBSTANTIAL COMPLETION

- A. Prior to substantial completion CMAR shall review Contract Documents for items which are not complete or need to yet be completed including submittal of all manuals, and testing reports. CMAR shall make a list of incomplete work, a value of the incomplete work, and reasons why work is incomplete. CMAR shall complete all items required to be completed as part of substantial completion.

- B. CMAR shall provide a written notice to Engineer that the work, or specific portions of the work, is substantially complete and ready for review. If there are any items remaining to be corrected or completed CMAR shall submit a list of these items along with the notice of substantial completion. Along with the list of items the CMAR should provide a written explanation of why these items are not considered necessary for substantial completion.
- C. Upon receipt of CMAR's notice of substantial completion, Engineer will proceed with inspection for substantial completion.
- D. Following the substantial completion inspection by the Engineer and Engineer's subconsultants, Engineer will either prepare certificate of substantial completion, or notify the CMAR in writing that substantial completion has not been meant listing the various reasons.
- E. CMAR shall promptly complete the items required to meet substantial completion and submit a second notice of substantial completion to the Engineer.
- F. Engineer will review the work a second time to determine the status of substantial completion.
- G. When Engineer considers the project to be substantially complete, Engineer will prepare the preliminary certificate of substantial completion along with a substantial completion punch list of items to be completed prior to final payment. Engineer will deliver preliminary certificate and punch list to Owner and consider any objections by the Owner as provided in the Conditions of the Contract.
- H. Upon agreement by Owner and Engineer of substantial completion and punch list items, Engineer will execute and deliver to the CMAR and Owner a final certificate of substantial completion along with substantial completion punch list of items to be completed prior to final payment.
- I. A maximum of two (2) reviews of substantially complete work will be completed by Engineer and Engineer's subconsultants for any one portion of work under the Contract. Should a third or subsequent reviews be necessary the following requirements will be met:
 - 1. Owner will compensate Engineer for additional reviews.
 - 2. Owner will deduct the amount of compensation paid to the Engineer for additional reviews from the payment to the CMAR.
 - 3. Compensation shall be at Engineer's standard hourly rates plus actual cost of reimbursables.

1.04 FINAL COMPLETION

- A. Following substantial completion CMAR shall complete remaining work and items to be corrected as part of substantial completion punch list as well as final cleaning and transferring site to Owner.
- B. When CMAR considers that all work is complete, CMAR shall provide written notice of final completion to Engineer.
- C. Following receipt of final completion certification, Engineer and Engineer's subconsultants shall review the work to verify that the requirements for final completion have been met.
- D. Upon review of work for final completion Engineer will either request the CMAR to make closeout submittals or will notify CMAR that the work is not complete with a list of incomplete or defective work. CMAR shall promptly take steps to correct all listed deficiencies and incomplete work before sending a second written notice of final completion certification to Engineer.
- E. If final completion was not met following first review, Engineer will review work a second time to determine if the requirements for final completion have been met.
- F. A maximum of two (2) reviews of final complete work will be completed by Engineer and Engineer's subconsultants for any one portion of work under the Contract. Should a third or subsequent reviews be necessary the following requirements will be met:
 - 1. Owner will compensate Engineer for additional reviews.
 - 2. Owner will deduct the amount of compensation paid to the Engineer for additional reviews from the payment to the CMAR.
 - 3. Compensation shall be at Engineer's standard hourly rates plus actual cost of reimbursables.
- G. When Engineer considers all work to be complete in accordance with the Contract Documents, Engineer shall request the CMAR to make closeout submittals.

1.05 FINAL CLEANING

- A. Execute final cleaning prior to final project assessment.
- B. Clean debris from gutters and drainage systems.
- C. Clean site; sweep paved areas, rake clean landscaped surfaces.
- D. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.06 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling current and future reference by Owner and Engineer.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish first floor datum.
 - 2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 4. Field changes of dimension and detail.
 - 5. Details not on original Contract drawings.
- G. Submit documents to Engineer with claim for final Application for Payment.

1.07 SPARE PARTS AND MAINTENANCE PRODUCTS

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

1.08 WARRANTIES AND BONDS

- A. Provide duplicate notarized copies.

- B. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers.
- C. Provide Table of Contents and assemble in D size three ring binders with durable plastic cover.
- D. Submit prior to final Application for Payment.
- E. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance.

1.09 MAINTENANCE SERVICE

- A. Furnish service and maintenance of components during the warranty period.
- B. Examine system components at a frequency consistent with reliable operation. Clean, adjust, and lubricate as required.
- C. Include systematic examination, adjustment, and lubrication of components. Repair or replace parts whenever required. Use parts produced by the manufacturer of the original component.
- D. Maintenance service shall not be assigned or transferred to any agent or Subcontractor without prior written consent of the Owner.

1.10 FINAL ADJUSTMENT OF ACCOUNTS

- A. CMAR shall submit a final statement of accounting to Engineer. Statement shall reflect all adjustments to the contract sum and include the following:
 - 1. Original contract sum.
 - 2. Additions and deductions resulting from:
 - a. All previous change orders
 - b. Allowances
 - c. Unit prices
 - d. Deductions for uncorrected work
 - e. Penalties and bonuses
 - f. Deductions for liquidated damages
 - g. Deductions for multiple reviews
 - h. Other adjustments
 - 3. Total contract sum as adjusted.
 - 4. Previous payments.
 - 5. Sum remaining due.
- B. Engineer will prepare a final change order, reflecting approved adjustments to the contract sum which were not previously made by change orders.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 77 00

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Quality Assurance.
2. Format.
3. Contents of Each Volume.
4. Manual for Equipment and Systems.
5. Instruction of Owner's personnel.
6. Submittals.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures 01 33 00 – Submittal Procedures.
2. Section 01 45 00 - Quality Control.
3. Section 001 77 00 - Closeout Procedures.

1.02 QUALITY ASSURANCE

- A. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

1.03 FORMAT

- A. Prepare data in the form of an instructional manual. Arrange data in numerical format.
1. Binders:
 - a. Commercial quality, 8-1/2 x 11 inch three D side ring binders with durable plastic covers.
 - b. 2 inch maximum ring size.
 - c. When multiple binders are used, correlate data into related consistent groupings.
 2. Cover; Identify:
 - a. Each binder with typed title OPERATION AND MAINTENANCE INSTRUCTIONS.
 - b. Title of Project.
 - c. Subject matter of contents.
 - d. Volume number.
 - e. Year of construction.
 3. Provide tabbed dividers for each separate product and system, with typed description of product and major component parts of equipment.

- B. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.
- C. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages. Folded paper should be unfoldable without removal from binder.
- D. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, in three parts as follows:
 - 1. Part 1: Directory, listing names, addresses, and telephone numbers of Engineer, CMAR, Subcontractors, and major equipment suppliers.
 - 2. Part 2: Operation and maintenance instructions, arranged by system and subdivided by specification section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers.
Identify the following:
 - a. Significant design criteria.
 - b. List of equipment.
 - c. Parts list for each component.
 - d. Operating instructions.
 - e. Maintenance instructions for equipment and systems.
 - 3. Part 3: Project documents and certificates, including the following:
 - a. Shop drawings and product data.
 - b. Certificates.
 - c. Photocopies of warranties.
 - d. Bonds.
- E. Flash Drive:
 - 1. A flash drive shall be provided with all documents included with an index, tabs, and labels as previously required for the binders.

1.04 CONTENTS OF EACH VOLUME

- A. Table of Contents: Provide title of Project; names, addresses, and telephone numbers of Engineer, Subconsultants, and CMAR with name of responsible parties; schedule of products and systems, indexed to content of the volume.
- B. For Each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- C. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- D. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.

- E. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.
- F. Warranties: Prepare and submit per Section 01 77 00 - Closeout Procedures.
- G. Bonds: Prepare and submit per Section 01 77 00 - Closeout Procedures.
- H. Flash Drive: A flash drive shall be provided with all volume contents in electronic format or scanned to a portable document file (.pdf). The documents shall be placed as required under the appropriate tabs and labels as previously required for the compact discs. Each file shall be adequately labeled to identify the contents without opening the document.

1.05 MANUAL FOR EQUIPMENT AND SYSTEMS

- A. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.
- B. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and troubleshooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- C. Provide servicing and lubrication schedule, and list of lubricants required.
- D. Include manufacturer's printed operation and maintenance instructions.
- E. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- F. Provide CMAR's coordination drawings, with color coded piping diagrams as installed.
- G. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- H. Provide list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage, and local sources of supply.
- I. Additional Requirements: As specified in individual Product specification sections.
- J. Provide a listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

- K. Flash Drive: A flash drive shall be provided with all manuals in electronic format or scanned to a portable document file (.pdf). The documents shall be placed as required under the appropriate tabs and labels as previously required for the compact disc. Each file shall be adequately labeled to identify the contents without opening the document.

1.06 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times.
- B. For equipment requiring seasonal operation, perform instructions for other seasons within six (6) months.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instruction.

1.07 SUBMITTALS

- A. Submit electronic copies of preliminary draft or proposed formats and outlines of contents before Substantial Completion. Engineer will review draft and return one copy with comments.
- B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.
- C. Submit electronic copies of completed volumes fifteen (15) working days prior to final inspection. One (1) copy will be returned after final inspection, with Engineer comments. Revise content of all document sets as required prior to final submission.
- D. Submit two (2) sets of revised final volumes in final form within ten (10) days after final inspection.
- E. Submit a minimum of two (2) complete copies of the flash drives with final documents in electronic format within then (10) days after final inspection.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 01 78 23

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SECTION 01 79 00
CLASSROOM DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 SUMMARY

- A. Classroom training and demonstration training of products and systems to be commissioned and where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. Electrical systems and equipment.
 - 3. Items specified in individual product Sections.
- C. Section includes:
 - 1. Quality Assurance.
 - 2. Scheduling.
 - 3. Demonstration Testing.
 - 4. Equipment Training.

1.02 RELATED REQUIREMENTS

- A. Section 01 33 00 - Submittal Procedures.
- B. Section 01 91 00 - Commissioning.
- C. Other Specification Sections: Additional requirements for classroom and demonstration training.
- D. Related Sections include:
 - 1. Section 01 45 00 - Quality Control.
 - 2. Section 01 77 00 - Closeout Procedures.
 - 3. Section 01 78 23 - Operation and Maintenance Data.

1.03 SUBMITTALS

- A. Draft Training Plans: Owner will designate personnel to be trained; tailor training to needs and skill-level of attendees.
 - 1. Submit to Engineer for transmittal to Owner.
 - 2. Submit not less than four(4) weeks prior to start of training.
 - 3. Revise and resubmit until acceptable.
 - 4. Provide an overall schedule showing all training sessions.
 - 5. Include at least the following for each training session:

- a. Identification, date, time, and duration.
 - b. Description of products and/or systems to be covered.
 - c. Name of firm and person conducting training; include qualifications.
 - d. Intended audience, such as job description.
 - e. Objectives of training and suggested methods of ensuring adequate training.
 - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
 - g. Media to be used, such as slides, hand-outs, etc.
 - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- B. Training Manuals: Provide training manual for each attendee; allow for minimum of two (2) attendees per training session.
 1. Include applicable portion of Operations and Maintenance (O&M) manuals.
 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
 3. Provide one (1) extra copy of each training manual to be included with operation and maintenance data.
- C. Training Reports:
 1. Identification of each training session, date, time, and duration.
 2. Sign-in sheet showing names and job titles of attendees.
- D. Video Recordings: Submit digital video recording of each demonstration and classroom training session for Owner's subsequent use.
 1. Format: DVD Disc or Owner approved substitute.
 2. Label each disc and container with session identification and date.
 3. Include only one training session on each DVD.

1.04 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
 1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

1.05 SCHEDULING

- A. Classroom training shall occur after completion of Prefunctional Testing and prior to Performance and Operation Testing.
- B. Demonstration training shall occur after written acceptance of Functional Test completion.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 DEMONSTRATION TESTING

- A. Demonstrations conducted during system start-up and prefunctional testing do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration Training for Owner personnel shall not be conducted during Functional Testing.
- C. Demonstration training may be conducted prior to or during Performance and Operational Testing.
- D. Provide a qualified person who is knowledgeable about the project and the specific equipment and systems to perform demonstration and instruction of Owner personnel.
- E. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
- F. Utilize Operation and Maintenance manuals as basis for demonstration training.
- G. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.

3.02 CLASSROOM TRAINING

- A. Engineer will prepare the Training Plan based on draft plans submitted by Contractor.
- B. Conduct training onsite unless otherwise indicated.
- C. Owner will provide classroom and seating at no cost to Contractor.
- D. Do not start training until Prefunctional Testing is complete, unless otherwise specified or approved by the Engineer.

- E. Provide training in minimum two hour segments.
- F. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by Owner, failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.
- G. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
 - 1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 - 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 - 3. Typical uses of the O&M manuals.
- H. Product- and System-Specific Training:
 - 1. Review the applicable O&M manuals.
 - 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 - 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 - 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 - 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 - 6. Discuss common troubleshooting problems and solutions.
 - 7. Discuss any peculiarities of equipment installation or operation.
 - 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 - 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 - 10. Review spare parts and tools required to be furnished by Contractor.
 - 11. Review spare parts suppliers and sources and procurement procedures.
- I. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three (3) days.

END OF SECTION 01 79 00

SECTION 01 91 00
COMMISSIONING

PART 1 - GENERAL

1.01 RELATED REQUIREMENTS

- A. Section 01 75 00 - Starting and Adjusting
- B. Section 01 78 23 - Operation and Maintenance Data

1.02 SUBMITTALS

- A. Manufacturers' Instructions: Submit copies of all manufacturer-provided instructions that are shipped with the equipment as soon as the equipment is delivered.
- B. Product Data: If submittals to Engineer do not include the following, submit copies as soon as possible:
 - 1. Manufacturer's product data, cut sheets, and shop drawings.
 - 2. Manufacturer's installation instructions.
 - 3. Startup, operating, and troubleshooting procedures.
 - 4. Fan and pump curves.
 - 5. Factory test reports.
 - 6. Warranty information, including details of Owner's responsibilities in regard to keeping warranties in force.
- C. Startup Plans and Reports.
- D. Completed Checklists.
- E. Commissioning Plan.
- F. Commissioning Reports.

1.03 DEFINITIONS

- A. Commissioning Plan: An overall plan, developed in conjunction with Owner, Engineer, and CMAR, that provides the structure, schedule, and coordination planning for the commissioning process.
- B. Functional Tests (FT): Test of the dynamic function and operation of equipment and systems using manual (direct observation) and/or remote monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operations. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures,

unoccupied, varying temperatures, alarm, power failure, local/remote, etc. FTs are performed after prefunctional tests and startups are completed.

- C. Performance and Operational Testing (POT): Test of systems after written acceptance of the FT. The POT test period will be used develop adequate process conditions to fully establish compliance with the performance requirements of the Contract Documents. CMAR shall supervise, control and be responsible for the operation and maintenance of equipment and systems during POT providing qualified and appropriately licensed personnel.

PART 2 - PRODUCTS

2.01 TEST EQUIPMENT

- A. Provide all standard testing equipment required to perform startup and initial checkout and required Functional Testing; unless otherwise noted such testing equipment will not become the property of the Owner.
- B. Calibration Tolerances: Provide testing equipment of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. If not otherwise noted, the following minimum requirements apply:
 - 1. Temperature Sensors and Digital Thermometers: Certified calibration within past year to accuracy of 0.5 degree F and resolution of plus/minus 0.1 degree F.
 - 2. Pressure Sensors: Accuracy of plus/minus 2.0 percent of the value range being measured (not full range of meter), calibrated within the last year.
 - 3. Calibration: According to the manufacturer's recommended intervals and when dropped or damaged; affix calibration tags or keep certificates readily available for inspection.
- C. Equipment-Specific Tools: Where special testing equipment, tools and instruments are specific to a piece of equipment, are only available from the vendor, and are required in order to accomplish startup or Functional Testing, provide such equipment, tools, and instruments as part of the work at no extra cost to the Owner such equipment, tools, and instruments are to become the property of the Owner
- D. Data loggers: Independent equipment and software for monitoring flows, currents, status, pressures, etc. of equipment.
 - 1. Data loggers required for Functional Tests will be provided by the CMAR and will not become the property of the Owner.

PART 3 - EXECUTION

3.01 COMMISSIONING PLAN

- A. Engineer, Owner, and CMAR will develop the Commissioning Plan.
 - 1. Engineer to attend meetings called by the CMAR for purposes of completing the commissioning plan.
 - 2. Require attendance and participation of relevant subcontractors, installers, suppliers, and manufacturer representatives.
- B. CMAR is responsible for compliance with the Commissioning Plan.
- C. Commissioning Schedule:
 - 1. Submit anticipated dates of startup of each item of equipment and system to Engineer within 60 days after award of Contract.
 - 2. Re-submit anticipated startup dates monthly, but not less than 4 weeks prior to startup.
 - 3. Prefunctional Checklists and Functional Tests are to be performed in sequence from components, to subsystems, to systems.
 - 4. Provide sufficient notice to Engineer for delivery of relevant Checklists and Functional Test procedures, to avoid delay.

3.02 STARTUP PLANS AND REPORTS

- A. Startup Plans: For each item of equipment and system for which the manufacturer provides a startup plan, submit the plan not less than 8 weeks prior to startup.
- B. Startup Reports: For each item of equipment and system for which the manufacturer provides a startup checklist (or startup plan or field checkout sheet), document compliance by submitting the completed startup checklist prior to startup, signed and dated by responsible entity.
- C. Submit directly to the Engineer.

3.03 FUNCTIONAL TESTS

- A. Functional Test is required for each item of equipment, system, or other assembly specified to be commissioned, unless sampling of multiple identical or near-identical units is allowed by the final test procedures.
- B. CMAR is responsible for execution of required Functional Tests, after completion of Prefunctional Checklist and before Substantial Completion.
- C. Engineer will witness Functional Tests, CMAR shall provide adequate notice to Engineer in advance of functional testing.
- D. CMAR is responsible for correction of deficiencies and re-testing at no extra cost to the Owner; if a deficiency is not corrected and re-tested immediately, the

Engineer will document the deficiency and the CMAR's stated intentions regarding correction.

1. Deficiencies are any condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents or does not perform properly.
2. When the deficiency has been corrected, the CMAR completes the form certifying that the item is ready to be re-tested and returns the form to the Engineer; the CMAR will reschedule the test and the CMAR shall re-test.
3. Identical or Near-Identical Items: If 10 percent, or three, whichever is greater, of identical or near-identical items fail to perform due to material or manufacturing defect, all items will be considered defective; provide a proposal for correction within 2 weeks after notification of defect, including provision for testing sample installations prior to replacement of all items.
4. CMAR shall bear the cost of Owner and Engineer's personnel time witnessing re-testing.

E. Functional Test Procedures:

1. Some test procedures are included in the Contract Documents; where Functional Test procedures are not included in the Contract Documents, test procedures will be determined by the Engineer and CMAR.
2. Traditional air or water test and balancing (TAB) is not Functional Testing; spot checking of TAB by demonstration to the Engineer is Functional Testing.

F. Deferred Functional Tests: Some tests may need to be performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions; performance of these tests remains the CMAR's responsibility regardless of timing.

3.04 FUNCTIONAL TEST PROCEDURES – GENERAL

- A. Provide skilled technicians to execute starting of equipment and to execute the Functional Tests. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments and problem-solving.
- B. Provide all necessary materials and system modifications required to produce the flows, pressures, temperatures, and conditions necessary to execute the test according to the specified conditions. At completion of the test, return all affected equipment and systems to their pre-test condition.
- C. Manual Testing: Use hand-held instruments, immediate control system readouts, or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").

- D. Simulating Conditions: Artificially create the necessary condition for the purpose of testing the response of a system; for example, apply hot air to a space sensor using a hair dryer to see the response in a VAV box.
- E. Simulating Signals: Disconnect the sensor and use a signal generator to send an amperage, resistance or pressure to the transducer and control system to simulate the sensor value.
- F. Over-Writing Values: Change the sensor value known to the control system in the control system to see the response of the system; for example, change the outside air temperature value from 50 degrees F to 75 degrees F to verify economizer operation.
- G. Indirect Indicators: Remote indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100 percent closed, are considered indirect indicators.
- H. Monitoring: Record parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or the trending capabilities of the relevant control systems; where monitoring of specific points is called for in Functional Test Procedures:
 - 1. All points that are monitored by the relevant control system shall be trended by CMAR; at the Engineer's request, Contractor shall trend up to 20 percent more points than specified at no extra charge.
 - 2. Other points will be monitored by the CMAR using data loggers.
 - 3. At the option of the Engineer, some control system monitoring may be replaced with data logger monitoring.
 - 4. Provide hard copies of monitored data in columnar format with time down left column and at least 5 columns of point values on same page.
 - 5. Graphical output is desirable and is required for all output if the system can produce it.
 - 6. Monitoring may be used to augment manual testing.

3.05 PERFORMANCE AND OPERATIONAL TESTING

- A. CMAR shall supervise, control, and be responsible for the operation and maintenance of the new equipment and/or system during a period of at least fifteen (15) days or until performance requirements are met, whichever is greater, after the written acceptance of the FT for each individual item that is placed into operation. The CMAR shall remain responsible for making required changes, repairs and replacements to the installation during this period. Final written acceptance of the equipment shall not be given until after fifteen (15) days of continuous successful operation.

- B. The POT test period will be used develop adequate process conditions to fully establish compliance with the performance requirements of the Contract Documents. Included in this requirement, but not limited to, are the following:
 - 1. Establishing and maintaining an adequate microbial population in the aeration system to meet NPDES permit limits.
 - 2. Generating sufficient materials to verify operation of materials handling equipment such as RAS and WAS pumping, and scum removal.
- C. During the POT, the CMAR shall provide supervisory and appropriately licensed personnel satisfactory to the Engineer. It is the intent that during the POT period, the Owner's personnel will become completely familiar with the operation and maintenance of the systems undergoing POT. See Section 01 79 00 - Classroom Demonstration and Training for additional requirements.
- D. During the POT, the Owner will arrange to have a complement of operating personnel available, and these operators will be paid by the Owner.

3.06 OPERATION AND MAINTENANCE MANUALS

- A. See Section 01 78 23 - Operation and Maintenance Data for additional requirements.
- B. Add design intent documentation furnished by Engineer to manuals prior to submission to the Owner
- C. Submit manuals related to items that were commissioned to Engineer for review; make changes recommended by Engineer.
- D. CMAR will add commissioning records to manuals prior to submission to Owner.

END OF SECTION 01 91 00

DIVISION 02

EXISTING CONDITIONS

SECTION 02 41 13
SELECTIVE SITE DEMOLITION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Extent of selective demolition work is indicated on Drawings.
- B. Types of Selective Demolition Work: Demolition requires the selective removal and subsequent offsite disposal of the following:
 - 1. Removal of site items indicated in Drawings.
- C. Removal and satisfactory disposal of pavement materials including asphalt pavement, concrete pavement, concrete driveways, alleys, sidewalks, handicapped curb ramps, and curb and gutter.
- D. Related work specified elsewhere: Remodeling construction work and patching is included within the respective sections of specifications, including removal of materials for re-use and incorporated into remodeling or new construction.
- E. Relocation of pipes, conduits, ducts, other mechanical and electrical work are specified by respective trades.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.

1.03 REFERENCES

- A. General Industry Safety and Health Standards, Occupational Safety and Health Administration (OSHA), as found in Code of Federal Register (CFR) in 29 CFR 1910.

1.04 SUBMITTALS

- A. Schedule: Submit schedule indicating proposed methods and sequence of operations for selective demolition work to Engineer for review prior to commencement of work. Include coordination for shut-off, capping, and continuation of utility services as required, together with details for dust and noise control protection.
- B. Provide detailed sequence of demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.

- C. Coordinate with Owner's continuing occupation of portions of existing building, and with Owner's reduced usage of any portion thereof.
- D. Submit project record documents under provisions of Section 01 77 00.

1.05 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for worker safety, confined space entry, dust control, and water and sludge discharges and disposal.
- B. Obtain required permits from authorities.
- C. Notify affected utility companies before starting Work and comply with applicable requirements.
- D. Do not close or obstruct roadways except as permitted by Owner. Do not close or obstruct egress width to exits without prior written permission of Owner.
- E. Do not disrupt or compromise effectiveness of existing facilities without written permission of Owner.
- F. Conform to procedures applicable if hazardous materials or situations discovered.

1.06 SCHEDULING

- A. Schedule Work under the provisions of Sections 01 11 13.
- B. Schedule Work to coincide with new construction and Owner operations.
- C. Fully describe demolition preparation, including saw cutting, coring, demolition, and removal procedures; schedule; temporary structural supports; environmental controls; disposal plans; and surface and substrate preparations for subsequent work.
- D. Existing lift station shall remain in operation until new lift station is operational. Demolition work shall not commence until new lift station is operational.

1.07 JOB CONDITIONS

- A. Occupancy: Owner will be continuously occupying areas immediately adjacent to areas of selective demolition. Conduct selective demolition work in manner that will minimize need for disruption of Owner's normal operations. Provide minimum of 72 hours advance notice to Owner of demolition activities which will severely impact Owner's normal operations.
- B. Condition of Structures: Owner assumes no responsibility for actual condition of items to be demolished.

1. Conditions existing at time of commencement of contract will be maintained by Owner insofar as practicable. However, variations may occur by Owner's removal and salvage operations prior to start of selective demolition work.
- C. Partial Demolition and Removal: Materials of marketable value that are removed in accordance with the provisions of the Project, but that are not to be possessed by the Owner, shall become the property of the CMAR and shall be removed from the right-of-way. Transport salvaged items from site as they are removed.
1. Storage or sale of removed items on site will not be permitted.
- D. Protections: Provide temporary barricades and other forms of protection as required to protect Owner's personnel and general public from injury due to selective demolition work.
1. Confine Work and stockpiling to within Owner's property or easement as approved by Engineer. Leave undisturbed all street and utility appurtenances not indicated for removal or renovation.
 2. Provide protective measures as required to provide free and safe passage of Owner's personnel and general public to and from occupied portions of buildings.
 3. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of element to be demolished, and adjacent facilities or work to remain.
 4. Maintain, during operation and at completion, pavement removal areas in such condition that they will be well drained at all times.
 5. Protect and maintain survey monuments or any construction staking from disturbance during pavement removal.
- E. Damages: Promptly repair damages caused to adjacent facilities by demolition work at no cost to Owner.
- F. Explosives: Use of explosives will not be permitted.
- G. Utility Services: Maintain existing utilities indicated to remain, keep in service, and protect against damage during demolition operations.
- H. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities as acceptable to governing authorities.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Prior to commencement of selective demolition work, inspect areas in which work will be performed. Photograph existing conditions to structure surfaces, equipment or to surrounding properties which could be misconstrued as damage resulting from selective demolition work; file with Owner's Representative prior to starting work.

3.02 PREPARATION

- A. Become familiar with required lines of removal and saw cutting.
- B. Identify underground utilities.
- C. Provide, erect, and maintain adequate barriers and warning lights.
- D. Keep streets, sidewalks, and driveways in usable condition; avoid property owner inconvenience insofar as practicable; do not trespass on private property.
- E. Verify traffic control in place prior to commencement of pavement removal.
- F. Inspect and record existing conditions onsite and at adjacent areas prior to starting construction. Commencement of this Section's Work means acceptance of existing conditions.
- G. Locate, identify, stub off and disconnect utility services that are not indicated to remain.
- H. Provide by-pass connections as necessary to maintain continuity of service.

3.03 DEMOLITION

- A. Perform selective demolition work in a systematic manner. Use such methods as required to complete work indicated on Drawings in accordance with demolition schedule and governing regulations.
 - 1. Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- B. If unanticipated mechanical, electrical or structural elements which conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report to Owner's Representative in written, accurate detail. Pending receipt of directive from Owner's Representative rearrange selective demolition schedule as necessary to continue overall job progress without delay.

- C. Salvage Items: Where indicated on Drawings as "Salvage", carefully remove indicated items, clean, store and turn over to Owner and obtain receipt.

3.04 PAVING REMOVAL

- A. Saw cutting will be required on concrete and asphalt pavements. Pavement removal beyond the limits established in the notes on the Drawings shall be replaced at the CMAR's expense.
- B. Saw cut vertically; remove on straight lines approximately parallel or perpendicular to centerline of pavement.
- C. Saw cut vertically full depth to obtain a clean break. After saw cutting, use pneumatic jackhammer or similar device prior to breaking out pavement.
- D. Break out remainder of pavement.
- E. Disturbances, breakage, or damage to areas not designated for removal shall be restored at CMAR's expense prior to making final payment.
- F. Leave underlying sub-base material in a condition suitable for traffic if construction sequence involves delays and if local situation requires access by the public.
- G. Pavement removed beyond the limits established shall be replaced to the same specifications as the adjacent removal at CMAR's expense.
- H. Pavers shall be removed and salvaged without imposing any damage.

3.05 TOLERANCES

- A. Saw cut full depth to achieve a clean break.
- B. If line of removal falls within 2 feet of an existing joint, adjust line of removal to be the existing joint.
- C. Remove entire width of sidewalk if removal width is less than sidewalk width.

3.06 DISPOSAL

- A. Remove broken pavement and dispose of materials not indicated to be stockpiled or remain as Owner's property to a location chosen by the CMAR that is acceptable to local authorities and regulatory agencies.
- B. The CMAR shall provide the Engineer with information and documentation substantiating proper disposal arrangements and operations. All material generated by this project must be disposed of at a permitted site. Depending on what material is generated and whether it is contaminated or uncontaminated will determine which permitted facility can accept it. Permitted facilities include

construction and demolition debris sites, restricted use sites, and regional landfills. Contact the SD DANR Waste Management Program at 605-773-3153 to identify locally permitted disposal sites for various categories of contaminated and uncontaminated materials.

END OF SECTION 02 41 13

SECTION 02 42 00
REMOVAL AND SALVAGE OF CONSTRUCTION MATERIALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Removal and salvage of Selective Site Demolition and Structure Demolition.

1.02 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. Section 02 41 13 - Selective Site Demolition.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 SALVAGE MATERIALS

- A. Salvage Items: Where indicated on Drawings as "Salvage", carefully remove indicated items, clean, store and turn over to Owner and obtain receipt.
- B. Historic artifacts, including cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historic significance remain the property of the Owner. Notify Owner's Representative if such items are encountered and obtain acceptance regarding method of removal and salvage for Owner.

3.02 DISPOSAL OF DEMOLISHED MATERIALS

- A. Remove debris, rubbish and other materials resulting from demolition operations. Transport and legally dispose of materials off site.
 - 1. If hazardous materials are encountered during demolition operations, comply with applicable regulations, laws, and ordinances concerning removal, handling and protection against exposure or environmental pollution.
 - 2. Burning of removed materials is not permitted on project site.

END OF SECTION 02 42 00

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DIVISION 03 CONCRETE

SECTION 03 01 00
MAINTENANCE OF CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Cleaning of concrete surfaces.
- B. Repair of exposed structural, shrinkage, and settlement cracks.
- C. Resurfacing of concrete surfaces having spalled areas and other damage.
- D. Patching of new concrete surfaces.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- B. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2026.
- C. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2026.
- D. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- E. ASTM C348 - Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars; 2021.
- F. ASTM C404 - Standard Specification for Aggregates for Masonry Grout; 2024.
- G. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2020a.
- H. ASTM C928/C928M - Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs; 2025.
- I. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2024.

1.04 SUBMITTALS

- A. See Division 01.

- B. Product Data: Indicate product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.
- C. Installer's qualification statement.
- D. Project Record Documents: Accurately record actual locations of structural reinforcement repairs and type of repair.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with minimum of 3 years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturers' instructions for storage, shelf life limitations, and handling of products.

PART 2 - PRODUCTS

2.01 CLEANING MATERIALS

- A. Degreaser:
 - 1. Manufacturers:
 - a. Euclid Chemical Company; Euco Clean and Strip: www.euclidchemical.com/#sle.
 - b. SpecChem, LLC; Orange Peel: www.specchemllc.com.
 - c. W. R. Meadows, Inc: www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 01 61 00 - Common Product Requirements.
- B. Detergent: Non-ionic detergent.
- C. Blasting Medium: As recommended by product supplier.

2.02 CEMENTITIOUS PATCHING AND REPAIR MATERIALS

- A. Manufacturers:
 - 1. BASF Corporation: www.buildingsystems.basf.com.
 - 2. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - 3. Euclid Chemical Company: www.euclidchemical.com/#sle.
 - 4. SpecChem, LLC: www.specchemllc.com/#sle.
 - 5. W. R. Meadows, Inc; _____: www.wrmeadows.com/#sle.

6. L&M Construction Chemicals, Inc.: www.lmcc.com.
 7. Five Star Products, Inc.: www.fivestarproducts.com.
 8. Xypex: www.xypex.com.
 9. Substitutions: Not permitted.
- B. Cementitious Resurfacing Mortar: One- or two-component, factory-mixed, polymer-modified cementitious mortar designed for continuous thin-coat application.
1. In-place material capable of withstanding freeze/thaw conditions (if required by the Engineer).
 2. Mixed with water or latex type bonding agent in proportions as recommended by manufacturer.
 3. Integral corrosion inhibitor.
 4. Color: As directed by Engineer.
 5. Products: As determined by the manufacturers listed above.
- C. Cementitious Repair Mortar, Trowel Grade: One- or two-component, factory-mixed, polymer-modified cementitious mortar.
1. In-place material resistant to freezing conditions.
 2. Mixed with water or latex type bonding agent in proportions as recommended by manufacturer.
 3. Integral corrosion inhibitor.
 4. Products: As determined by the manufacturers listed above.
- D. Cementitious Repair Mortar, Form and Pour/Pump Grade: Flowable, one- or two-component, factory-mixed, polymer-modified cementitious mortar; in-place material resistant to freezing conditions.
1. Mixed with water in proportions as recommended by manufacturer.
 2. Integral corrosion inhibitor.
 3. Products: As determined by the manufacturers listed above.
- E. Cementitious Hydraulic Waterstop: Very fast setting, low slump, hand formable, and capable of stopping active water leaks; in-place material resistant to freeze/thaw conditions.
1. Products: As determined by the manufacturers listed above.

2.03 EPOXY PATCHING AND REPAIR MATERIALS

A. Manufacturers:

1. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
2. Euclid Chemical Company: www.euclidchemical.com/#sle.
3. SpecChem, LLC: www.specchemllc.com/#sle.

4. W. R. Meadows, Inc; _____: www.wrmeadows.com/#sle.
- B. Epoxy Repair Mortar: Epoxy resin mixed with aggregate and other materials in accordance with manufacturer's instructions for purpose intended; comply with pot life and workability limits.
 1. Products: As determined by the manufacturers listed above.
- C. Epoxy Injection Adhesive:
 1. Products: As determined by the manufactures listed above.
- D. Epoxy Bonding Adhesive: Non-sag, two-component, 100 percent solids; recommended by manufacturer for purpose and conditions under which used.
 1. Non-Load-Bearing Applications: ASTM C881/C881M, Type I, II, III, IV, or V, whichever is appropriate to application.
 2. Load-Bearing Applications: ASTM C881/C881M, Type IV or V, whichever is appropriate to application.
 3. Products: As determined by the manufacturers listed above.

2.04 ACCESSORIES

- A. Portland Cement: ASTM C150/C150M, Type I, grey.
- B. Sand: ASTM C33/C33M or ASTM C404; uniformly graded, clean.
- C. Water: Clean and potable.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Beginning of installation means acceptance of substrate.

3.02 CLEANING EXISTING CONCRETE

- A. Provide enclosures, barricades, and other temporary construction as required to protect adjacent work from damage.
- B. Clean concrete surfaces of dirt or other contamination using the gentlest method that is effective.
 1. Try the gentlest method first, then, if not clean enough, use a less gentle method taking care to watch for impending damage.
 2. Clean out cracks and voids using same methods.

- C. The following are acceptable cleaning methods, in order from gentlest to less gentle:
1. Water washing using low-pressure, maximum of 100 psi, and, if necessary, brushes with natural or synthetic bristles.
 2. Increasing the water washing pressure to maximum of 400 psi.
 3. Adding detergent to washing water; with final water rinse to remove residual detergent.
 4. Steam-generated low-pressure hot-water washing.
 5. Abrasive blasting: Use only abrasive media that have been proven not to damage concrete by testing on mock-up.

3.03 CONCRETE SURFACE REPAIR USING CEMENTITIOUS MATERIALS

- A. Clean concrete surfaces, cracks, and joints of dirt, laitance, corrosion, and other contamination using method(s) specified above and allow to dry.
- B. Apply coating of bonding agent to entire concrete surface to be repaired.
- C. Fill voids with cementitious mortar flush with surface.
1. Fill all voids (honeycombs, rock pockets, bug holes, air bubbles, etc.) with any dimension larger than 1/4" in new concrete.
 2. Coordinate work with final coating and liner systems if applicable.
- D. Apply repair mortar by steel trowel to a minimum thickness of 1/4 inch (6 mm) over entire surface, terminating at a vertical change in plane on all sides.
- E. Trowel finish to match adjacent concrete surfaces.
- F. Damp cure for four days.

END OF SECTION 03 01 00

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SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED REQUIREMENTS

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Section 05 12 00 - Structural Steel Framing: Placement of embedded steel anchors and plates in cast-in-place concrete.

1.03 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code for Structural Concrete—Code Requirements and Commentary; 2025.
- B. ACI PRC-347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
- C. ACI SPEC-117 - Specification for Tolerances for Concrete Construction and Materials and Commentary; 2010 (Reapproved 2015).
- D. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- E. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures: American Concrete Institute
- F. PS 1 - Structural Plywood; 2023.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Provide data on void form materials and installation requirements.
- C. Shop Drawings: Indicate pertinent dimensions, materials, bracing, and arrangement of joints and ties.

1.05 QUALITY ASSURANCE

- A. Designer Qualifications: Design formwork under direct supervision of a Professional Structural Engineer experienced in design of concrete formwork and licensed in the State in which the Project is located.

PART 2 - PRODUCTS

2.01 FORMWORK - GENERAL

- A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
- B. Design and construct concrete that complies with design with respect to shape, lines, and dimensions.
- C. Chamfer outside corners of beams, joists, columns, and walls.
 - 1. 3/4 inch (Typical)
- D. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- E. Comply with relevant portions of ACI CODE-318, ACI PRC-347, and ACI SPEC-301.
- F. Formwork Design and Construction: Comply with guidelines of ACI 347 to provide formwork that will produce concrete complying with tolerances of ACI 117.
- G. Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

2.02 WOOD FORM MATERIALS

- A. Form Materials: At the discretion of the Contractor.
- B. Form Facing for Exposed Finish Concrete: Contractor's choice of materials that will provide smooth, stain-free final appearance.

2.03 REMOVABLE PREFABRICATED FORMS

- A. Preformed Steel Forms: Minimum 16 gauge, 0.0598 inch (1.52 mm) thick, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.
- B. Preformed Plastic Forms: Thermoplastic polystyrene form liner, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

- C. Glass Fiber Fabric Reinforced Plastic Forms: Matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.
- D. Void Forms: Moisture resistant treated paper faces, biodegradable, structurally sufficient to support weight of wet concrete mix until initial set; 4 inches (100 mm) thick unless noted otherwise on drawings.

2.04 FORMWORK ACCESSORIES

- A. Form Ties: Removable or Snap-Off, fixed length, cone type, with waterproofing washer, 1-1/2 inch back break dimension, free of defects that could leave holes larger than 1-1/4 inch in concrete surface.
 - 1. Removable form tie plugs for through-wall removable ties shall be mechanical type plugs with stainless steel composition.
 - a. Products:
 - 1) Sika Corporation; Sika X-Plug.
 - 2) Substitutions: See Section 01 60 00 - Product Requirements
See Section 01 61 00 - Common Product Requirements
- B. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - 1. Do not use materials containing diesel oil or petroleum-based compounds.
 - 2. Product must meet NSF requirements.
 - 3. Products:
 - a. SpecChem, LLC; Bio Strip WB (water-based): www.specchemllc.com/#sle.
 - b. BASF Corporation: MasterFinish Series.
 - c. W.R. Meadows, Inc; Duogard Series: www.wrmeadows.com.
- C. Filler Strips for Chamfered Corners: Rigid plastic or Wood type; 3/4 inch (19 mm) size; maximum possible lengths.
- D. Flashing Reglets: Galvanized steel, at least 22 gage, 0.0299 inch (0.76 mm) thick, longest possible lengths, with alignment splines for joints, foam filled, release tape sealed slots, anchors for securing to concrete formwork.
- E. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

- F. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 12 00.
- G. Waterstops: As specified in Section 03 20 00.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Earth forms are not permitted without specific approval from the Engineer.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI SPEC-301.
- B. The forms shall be constructed, shored, braced and tied to maintain their position and shape during and after placing concrete. The forms shall have adequate stiffeners, wales and braces to prevent noticeable deflection or waviness. Forms shall be sufficiently rigid to limit deflection under the weight of wet concrete to 1/8 inch.
- C. Forms for beams, floor slabs and similar members shall be constructed with a camber in order that deflection due to the weight of forms, reinforcing, and wet concrete shall be zero to 1/2 inch positive camber after forms are removed.
- D. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- E. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- F. Align joints and make watertight to prevent leakage of mortar. Keep form joints to a minimum.
- G. Obtain approval before framing openings in structural members that are not indicated on drawings.
- H. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.
- I. Coordinate this section with other sections of work that require attachment of components to formwork.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.
- C. Do not apply form release agent where concrete surfaces will receive special finishes that are affected by agent.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Position recessed anchor slots for brick veneer masonry anchors and precast veneer anchors to spacing and intervals specified in other sections.
- E. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- F. Install formwork waterstops in accordance with manufacturer's instructions, so they are continuous without displacing reinforcement.
- G. Waterstops shall be installed and held rigidly in place prior to pouring concrete. Wet-setting waterstops if explicitly prohibited.
- H. 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.
- I. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.

1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI SPEC-117, unless otherwise indicated.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 45 00 .
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.

3.09 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
 1. Forms must be left in place for a minimum of 24 hours after concrete placement.
 2. Forms and shoring supporting elevated slabs must be left in place until the concrete has reached its specified 28 day compressive strength.
- B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- C. Concrete shall not display any evidence of damage or excessive deflection due to form removal or loss of temporary support.
- D. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.
- E. Shoring and/or forms shall be left in place as necessary to carry any construction equipment or materials that are placed during construction.

END OF SECTION 03 10 00

SECTION 03 20 00
CONCRETE REINFORCING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.
- C. Concrete anchors where otherwise not specified.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code for Structural Concrete—Code Requirements and Commentary; 2025.
- B. ACI MNL-66 - ACI Detailing Manual; 2020.
- C. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.
- E. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2026.
- F. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- G. CRSI (DA4) - Manual of Standard Practice; 2024.
- H. CRSI (P1) - Placing Reinforcing Bars, 10th Edition; 2019.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Submittals, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI MNL-66 Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.

1. Prior to submitting reinforcing shop drawings, submit all construction joint locations to Engineer for approval as specified in Section 03 30 00 - Cast-in-Place Concrete.
- C. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.
- D. Reports: Submit certified copies of mill test report of reinforcement materials analysis.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI SPEC-301.
- B. Provide Architect with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.

PART 2 - PRODUCTS

2.01 REINFORCEMENT

- A. Reinforcing Steel: ASTM A615/A615M, Grade 60 (60,000 psi) (420 MPa).
 1. Deformed billet-steel bars.
 2. Unfinished.
- B. Reinforcement Accessories:
 1. Tie Wire: Annealed, minimum 16 gauge, 0.0508 inch (1.29 mm).
 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcement during concrete placement.
 3. Provide stainless steel or plastic components for placement within 2 inches (50 mm) of weathering surfaces.
- C. Rebar Dowel Anchorage: Post installed epoxy and acrylic systems. Submit proposed system for each specific use.
 1. Submit proposed system for each specific use.

2.02 RE-BAR SPLICING:

- A. Coupler Systems: Mechanical devices for splicing reinforcing bars.
 1. Comply with ACI CODE-318 steel reinforcing design strength requirements for splices in tension and compression.
 2. To be used at locations shown on Drawings; or as proposed by Contractor for specific locations.
 3. Products:

- a. Dayton Superior Corporation: www.daytonsuperior.com/#sle.
 - b. Substitutions: See Section 01 61 00 - Common Product Requirements.
- B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for splicing reinforcing bars.
 - 1. Comply with ACI CODE-318 steel reinforcing design strength requirements for splices in tension and compression.
 - 2. To be used at locations shown on Drawings; or as proposed by Contractor for specific locations.

2.03 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice and ACI 318.
- B. Welding of reinforcement is permitted only with the specific approval of Architect. Perform welding in accordance with AWS D1.4.
- C. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 - 1. Submit and review locations of splices with Architect.

PART 3 - EXECUTION

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position.
- B. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- C. Do not displace or damage vapor barrier.
- D. Accommodate placement of formed openings.
- E. Maintain concrete cover as indicated on drawings.
- F. Conform to applicable code, contract drawings and General Structural Notes for concrete cover over reinforcement.
- G. Reinforcement shall not be cut unless shown on Structural drawings or by Engineer approval. Cut reinforcement shall be spliced with the following:
 - 1. Coupler system as shown above.
 - 2. Lap splice to meet Class B requirements.
 - 3. Engineer approved alternate method.

- H. All slab reinforcing must be on chairs. Hand lifting without supports during pour is prohibited.
- I. All dowels between concrete elements must be tied in place prior to pour. Wet sticking dowels during pour is prohibited.
- J. Reinforcement shall be free of foreign particles or coatings including form oils. Replace reinforcement that cannot be cleaned.
- K. Upon completion of placement of reinforcing, notify Engineer and allow 24 hours for review prior to commencement of concrete placement.
- L. Bond and ground all reinforcement to requirements of Section 26 05 26.

3.02 ANCHOR BOLTS AND EMBEDDED PARTS

- A. Anchor bolts and anchor bolt groups shall be supported and set using templates attached to the forms, and embedded ends securely tied to prevent displacement during placing of concrete.
- B. Tolerances from dimensions shown on the Drawing shall be in compliance with AISC "Code of Standard Practice for Steel Buildings and Bridges", AISC 303-05.
- C. Unless shown otherwise, anchor bolts shall be set perpendicular to the theoretical bearing surface. Welding to anchor bolts will not be permitted. Exposed anchor bolt threads shall be given a coat of grease and protected from corrosion or other damage to the threads.

END OF SECTION 03 20 00

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Concrete building frame members.
- B. Elevated concrete slabs.
- C. Floors and slabs on grade.
- D. Concrete shear walls, elevator shaft walls, and foundation walls.
- E. Controlled Low-Strength Material (CLSM).
- F. Bonding and jointing products, including waterstops.
- G. Joint devices associated with concrete work.
- H. Miscellaneous concrete elements, including equipment pads, equipment pits, light pole bases, flagpole bases, thrust blocks, and manholes.
- I. Concrete curing.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 03 20 00 - Concrete Reinforcing.
- C. All other specification sections defining items passing through or cast into concrete.

1.03 REFERENCE STANDARDS

- A. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
- B. ACI 301 - Specifications for Structural Concrete
- C. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- D. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
- E. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).

- F. ACI PRC-308 - Curing of Concrete—Guide; 2026.
- G. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- H. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
- I. ACI 305R - Specification for Hot Weather Concreting.
- J. ACI 306R - Guide to Cold Weather Concreting.
- K. ACI 308.1 - Standard Specification for Curing Concrete.
- L. ACI 318 - Building Code Requirements for Structural Concrete and Commentary.
- M. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- N. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2024a.
- O. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2026.
- P. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2026a.
- Q. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 50 mm [2 in.] Cube Specimens); 2026.
- R. ASTM C143/C143M - Standard Test Method for Slump of Concrete; 2026a.
- S. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
- T. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2020.
- U. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2026.
- V. ASTM C231/231M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
- W. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2024.
- X. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2025.
- Y. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2024.

- Z. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes; 2023.
- AA. ASTM C618 - Standard Specification for Coal Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2025a.
- BB. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2024.
- CC. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- DD. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete; 2025.
- EE. ASTM C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
- FF. ASTM D2103 - Standard Specification for Polyethylene Film; 2023a.
- GG. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2024.
- HH. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017 (Reapproved 2023).
- II. COE CRD-C 48 - Handbook for Concrete and Cement Standard Test Method for Water Permeability of Concrete; 1992.
- JJ. COE CRD-C 572 - Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop; 1974.
- KK. Portland Cement Association (PCA).
- LL. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- MM. PCA - Design and Control of Concrete Mixtures.

1.04 SUBMITTALS

- A. See Section 01 33 00 - Submittals, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.

1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Mix Design: Submit proposed concrete mix design. The mix design shall be specific to this project and conditions of placement. with a written request for acceptance. The data submitted shall include:
1. Indicate proposed mix design complies with requirements of ACI SPEC-301, Section 4 - Concrete Mixtures.
 2. Indicate proposed mix design complies with requirements of ACI 318 and ACI 350, Chapter 4 - Durability Requirements.
 3. Indicate proposed mix design complies with requirements of ACI 318 and ACI 350, Chapter 5 - Concrete Quality, Mixing and Placing.
 4. Indicate proposed mix design complies with fiber reinforcing manufacturer's written recommendations.
 5. Fine and coarse aggregate gradations per ASTM C33.
 6. Method of determining the mix design proportions.
 7. Water to cementitious material ratio.
 8. Air content and unit weight.
 9. Compressive strength at 7 and 28 days per ASTM C 39.
 10. The proportions and types of all materials including admixtures.
 11. The Shale and deleterious contents of all aggregates used.
 12. Sulfate-resistant cement test results per ASTM C 1012.
 13. Aggregate Alkali-Silica Reactivity test results per ASTM C 1567.
 14. Shrinkage (length change) test results per ASTM C 157.
- D. Submit proposed construction joint locations for all buildings to Engineer for approval.
1. Provide with numbering and sequencing.
 2. Provide mix design to be used for each installation.
 3. Submit proposed locations prior to submitting concrete reinforcing submittals.
- E. Test Reports: Submit report for each test or series of tests specified.
- F. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
- G. Submit hot weather concreting procedures for concreted installed and/or cured during temperatures described in ACI 305.1. These procedures shall be in conformance with ACI 305.1.
- H. Contractor shall adhere to and submit project specific cold weather concreting procedures conforming to ACI 306R-16. This shall apply for concrete installed and/or cured during temperatures described in ACI 306R-16.

1. Provide methods for placing concrete to ensure no damage from cold weather effects
 2. Provide methods for protecting concrete from cold weather and timing of addition/removal of thermal protection.
 - a. Concrete temperature sensors shall be permitted to be used to verify in-situ strength of concrete via ASTM C1074 maturity method only if administered and properly coordinated with independent testing agency prior to cold weather concrete submittal.
 3. Provide curing methods used to ensure proper design strength of concrete is met while following proper thermal protection procedures.
 4. Provide methods for ensuring concrete does not become damaged due to thermal shock upon removal of forms and/or thermal protection.
 5. Provide plans/sections showing cold weather concrete installation extents as supplemented by project construction joint submittal.
 - a. Concrete construction joint submittal shall precede cold weather concrete submittal.
 6. Provide anticipated temperature monitoring locations on plans/sections.
 7. Provide temperature record template which outlines cold weather relevant parameters to be documented and frequency of said documentation.
 - a. Cold weather record shall, at a minimum, include date, time, outside air temperature, temperature of concrete as placed, weather conditions, and location of temperature recording taken.
 - b. Concrete temperatures during cold weather concrete installation and curing procedures shall be taken no less than 2 times per 24 hours and shall not be separated by less than 8 hours.
- I. Contractor shall submit project specific cold weather concrete procedures for approval no less than 3 months prior to cold weather periods, as defined by ACI 306R-16 and as compared against National Weather Service Monthly Climate Normals.
- J. Concrete installation during cold weather, as defined by ACI 306R-16, shall only be permitted after submittal review and acceptance by the Engineer. Any concrete installed during cold weather which has not gone through project submittal procedure shall be considered defective concrete.
- K. Contractor shall calibrate external temperature monitoring devices with on site engineer's device prior to cold weather temperatures to find acceptable range of accuracy between devices. Failure to do so shall constitute assumption of accuracy of engineer's device within allowable tolerance as stated by manufacturer.
1. Provide written confirmation of temperature device accuracy to Engineer prior to commencing cold weather concrete installation

2. Contractor may assume on site engineer's temperature monitoring device performance specifications match that of Klein Tools IR5 Dual Laser Infrared Thermometer unless noted otherwise.
- L. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301, ACI 318, and ACI 350.
- B. Follow requirements of ACI 305.1 when concreting during hot weather.
- C. Follow requirements of ACI 306R-16 when concreting during cold weather.
- D. Schedule pre-pour meeting/conference with Engineer, concrete supplier, independent testing agency, and all sub-contractors at least one week prior first concrete pour.
 1. Additionally pre-pour conferences shall be held with Engineer at least one week prior to concrete pours greater than 150 cubic yards.

PART 2 - PRODUCTS

2.01 FORMWORK

- A. Comply with requirements of Section 03 10 00 - Concrete Forming and Accessories.

2.02 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 03 20 00 - Concrete Reinforcing.
- B. Synthetic Fiber Reinforcement: Fibermesh 300.
 1. Material: 100 percent virgin homopolymer polypropylene fibrillated fibers, containing no reprocessed olefin materials.
 2. Conformance: ASTM C 1116, Type III.
 3. Fiber Length: [Graded] [Single-cut lengths].
 4. Alkali Resistance: Alkali proof.
 5. Absorption: Nil.
 6. Specific Gravity: 0.91.
 7. Melt Point: 324 degrees F (162 degrees C).
 8. Manufacturers:
 - a. Propex Operating Company, LLC. PO Box 22788, Chattanooga, Tennessee 37422. Toll Free 800-621-1273. Website www.fibermesh.com.
 - b. Substitutions see Div 01

2.03 CONCRETE MATERIALS

- A. Cement: ASTM C595, Type 1L (HS).
 - 1. Acquire all cement for entire project from same source or resubmit mill certificates if a different source is required.
- B. Fine and Coarse Aggregates: ASTM C33/C33M.
 - 1. Acquire all aggregates for entire project from same source or resubmit aggregate data if a different source is required.
 - 2. Shale or deleterious content shall be no more than 0.5 percent for slabs and water bearing structures and 1 percent for all other concrete.
- C. Fly Ash: ASTM C618, Class F.
- D. Water: Per ASTM C1602 and "potable".
- E. Fiber Reinforcement: Alkali-resistant polypropylene containing no reprocessed olefin materials and complying with ASTM C1116/C1116M, Type III.
 - 1. Fiber Type: Alkali-resistant synthetic.
 - 2. Products:
 - a. Fibermesh; Enduro Mirage: www.fibermesh.com/#sle.
 - b. Fibermesh; Enduro Prime: www.fibermesh.com/#sle.
 - c. Fibermesh; Fibermesh 650: www.fibermesh.com/#sle.
 - d. Fibermesh 300.
 - e. Substitutions: See Section 01 61 00 - Common Product Requirements.

2.04 ADMIXTURES

- A. Do not use chemical admixtures that contain intentionally-added chlorides.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- D. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
- E. Accelerating Admixture: ASTM C494/C494M Type C.
- F. Retarding Admixture: ASTM C494/C494M Type B.
- G. Water Reducing Admixture: ASTM C494/C494M Type A.
- H. Shrinkage Reducing Admixture: ASTM C494/C494M Type S.
- I. Waterproofing Admixture: Admixture formulated to reduce permeability to liquid water, with no adverse effect on concrete properties.

1. Admixture Composition: Crystalline, functioning by growth of crystals in capillary pores.
2. Products:
 - a. Xypex Chemical Corporation; Xypex Admix C-500/C-500NF: www.xypex.com/#sle.

2.05 ACCESSORY MATERIALS

A. Underslab Vapor Retarder:

1. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
2. Products:
 - a. ISI Building Products; Viper VaporCheck II 15-mil (Class A): www.isibp.com/#sle.
 - b. Stego Industries, LLC; Class A - 15 mils: www.stegoindustries.com.
 - c. W. R. Meadows, Inc; PERMINATOR Class A - 10 mils (0.25 mm): www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 01 61 00 - Common Product Requirements.

B. Controlled Low-Strength Material (CLSM): Shall be a mixture of cement, Pozzolan, coarse and fine aggregate, admixtures, and water; mixed in accordance with ASTM C94 - Ready Mixed Concrete.

1. Locations: As specified on drawings.
2. Minimum Compressive Strength at 28 days:
 - a. Normal CLSM for pipeline shall be 100 psi.
 - b. Structural backfill or bearing CLSM shall be 1,000 psi.
3. Composition: As determined by the ready mix supplier to achieve the minimum strength required.
4. Total Air Content: 4 - 7 percent.
5. Maximum Slump: 9 inches.

C. Non-Shrink Cementitious Grout: Premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing agents.

1. Grout: Comply with ASTM C1107/C1107M.
2. Minimum Compressive Strength at 48 Hours, ASTM C109/C109M: 2,000 pounds per square inch (13.7 MPa).
3. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 7,000 pounds per square inch (48 MPa).
4. Flowable Products:
 - a. Five Star Products, Inc; Five Star Fluid Grout 100: www.fivestarproducts.com/#sle.
 - b. BASF Corporatio; MasterFlow: www.buildingsystems.basf.com

- c. W. R. Meadows, Inc; 588-10K: www.wrmeadows.com/#sle.
- d. Substitutions: See Section 01 61 00 - Common Product Requirements.
- 5. Low-Slump, Dry Pack Products:
 - a. Five Star Products, Inc; Five Star Grout: www.fivestarproducts.com/#sle.
 - b. BASF Corporation: MasterFlow 100: www.buildingsystems.basf.com
 - c. SpecChem, LLC; SC Multipurpose Grout: www.specchemllc.com/#sle.
 - d. Substitutions: See Section 01 61 00 - Common Product Requirements.

2.06 BONDING AND JOINTING PRODUCTS

- A. Latex Bonding Agent: Non-redispersable acrylic latex, complying with ASTM C1059/C1059M, Type II.
 - 1. Products:
 - a. SpecChem, LLC; Strong Bond Acrylic Bonder: www.specchemllc.com/#sle.
 - b. W. R. Meadows, Inc; ACRY-LOK: www.wrmeadows.com/#sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Waterstops: PVC, complying with COE CRD-C 572 and NSF 61.
 - 1. Configuration: As indicated on drawings.
 - 2. Type: Ribbed with center bulb.
 - 3. Placement:
 - a. Waterstop shall be continuous throughout the length of the joint and shall have equal embedment on both sides of the joint.
 - b. Waterstops shall be clean, free from coatings, and shall be maintained in final installed position prior to concrete placement until concrete has been deposited, compacted, and finished.
 - c. All splices in waterstop shall be fully heat welded.
 - 1) Provide factory made waterstop fabrications for all changes of direction, intersections, and transitions leaving only straight butt joint splices for the field.
 - d. Provide factory hog rings or grommets spaced at 12" o.c. to hold waterstop firmly in place.
 - 4. Store waterstops under tarps to protect from oil, dirt, and sunlight.
 - 5. Acceptable Products:
 - a. Profile 732 by Greenstreak unless noted otherwise.
 - 1) Provide profile 702 by Greenstreak where noted as 4 inch waterstop.
- C. Hydrophilic Rubber Waterstop:
 - 1. Minimum cross sectional dimensions shall be 3/16-inch by 3/4-inch.

2. Configuration: As indicated on the drawings.
 3. Acceptable Products:
 - a. Hydrotite by Greenstreak.
 4. Acceptable at locations shown on drawings or approved by Engineer.
- D. Hydrophilic Sealant:
1. Hydrophilic sealant shall adhere firmly to concrete, metal, and PVC in dry or damp condition. When cured sealant shall be elastic indefinitely.
 2. Acceptable Products:
 - a. Leakmaster LV-1 by Greenstreak.
- E. Slab Isolation Joint Filler: 1/2-inch (13 mm) thick, height equal to slab thickness, with removable top section forming 1/2-inch (13 mm) deep sealant pocket after removal.
1. Material: ASTM D1751, cellulose fiber.
 2. Products:
 - a. W. R. Meadows, Inc; Fibre Expansion Joint:
www.wrmeadows.com/#sle.
 - b. Substitutions: See Section 01 61 00 - Common Product Requirements.

2.07 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
1. Products must meet NSF requirements.
 2. Products:
 - a. SpecChem, LLC; SpecFilm Concentrate or SpecFilm:
www.specchemllc.com/#sle.
 - b. BASF Corporation; MasterKure ER 50:
www.buildingsystems.basf.com.
 - c. W. R. Meadows, Inc; Evapre or Evapre-RTU:
www.wrmeadows.com/#sle.
 - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.
1. Products must meet NSF requirements.
 2. Products:
 - a. SpecChem, LLC; E-Cure: www.specchemllc.com.
 - b. W. R. Meadows, Inc; 1100: www.wrmeadows.com/#sle.
 - c. Substitutions: See Section 01 61 00 - Common Product Requirements.

- C. Coordinate all curing materials with coatings and floor finishing. Use water curing for all applications unless approved by the Engineer.
- D. Moisture-Retaining Sheet: ASTM C171.
 - 1. Curing paper, regular.
 - 2. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard (1.71 kg/sq m).
- E. Polyethylene Film: ASTM D2103, 4 mil, 0.004 inch (0.102 mm) thick, clear.
- F. Water: Potable, not detrimental to concrete.

2.08 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
 - 1. For both methods, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.
- D. Shrinkage (Length Change):
 - 1. Determine length change of hardened concrete test specimens in accordance with ASTM C 157 / C 157M, except as noted. Existing test data from previous projects with the same materials may be acceptable.
 - 2. Test specimens shall be moist cured, including period in molds, for 7 days. After 7 days, the specimens shall be stored in air for a period of 28 days.
 - 3. Utilize concrete materials in specified mix designs.
 - 4. Report length change of specimens after periods of air drying after curing of 7, 14, and 28 days.
 - 5. Average length change after 28 days shall be limited to .04%.
- E. Normal Weight Concrete for all components of water bearing structures:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,500 psi.
 - 2. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
 - 3. Cement Content: Minimum 560 lb per cubic yard.

4. Water-Cementitious Material Ratio: Maximum 42 percent by weight.
 5. Total Air Content: As specified, determined in accordance with ASTM C231/C231M.
 - a. 5-8 percent for concrete exposed to freeze / thaw conditions.
 - b. 0 percent entrained for all other conditions.
 6. Maximum Slump: 4 inches (prior to high-range water reducing admixtures).
 7. Maximum Aggregate Size: 3/4 inch.
 8. Crystalline Admixture: Final rates determined by supplier.
 - a. Product: Xypex C-500.
 - b. Dosage Rate: 2-3 percent by weight of portland cement content.
 9. Mix design shall comply within limits for Shrinkage (Length Change).
 10. Concrete mix shall contain Xypex Crystalline Waterproofing admixture.
- F. Normal Weight Concrete for non-water bearing interior structural slabs, interior slabs on grade, concrete beams, concrete columns, topping slabs, pump bases, and other miscellaneous interior structural concrete (concrete not exposed to freeze thaw cycles):
1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,500 psi.
 2. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
 3. Cement Content: Minimum 560 lb per cubic yard
 4. Water-Cementitious Material Ratio: Maximum 42 percent by weight.
 5. Total Air Content: 0 percent (no entrained air).
 6. Maximum Slump: 4 inches (prior to high-range water reducing admixtures).
 7. Maximum Aggregate Size: 3/4 inch.
- G. Normal Weight Concrete for sidewalks, mechanical equipment pads, electrical equipment pads, non-water bearing exterior structural slabs, foundation mat slabs, pile caps, foundation footings, foundation walls, and other miscellaneous exterior structural concrete (concrete exposed to freeze thaw cycles):
1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,500 pounds per square inch.
 2. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
 3. Cement Content: Minimum 560 lb per cubic yard.
 4. Water-Cement Ratio: Maximum 42 percent by weight.
 5. Total Air Content: 5-8 percent, determined in accordance with ASTM C231/C231M.
 6. Maximum Slump: 4 inches (prior to high-range water reducing admixtures).
 7. Maximum Aggregate Size: 3/4 inch.

- H. Normal Weight Concrete for miscellaneous concrete elements, pipe supports, restraint concrete, equipment pads, and housekeeping pads:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,500 psi.
 - 2. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.
 - 3. Cement Content: Minimum 470 lb per cubic yard.
 - 4. Water-Cement Ratio: Maximum 45 percent by weight.
 - 5. Total Air Content: As specified, determined in accordance with ASTM C173/C173M.
 - a. 5%-8% percent for concrete exposed to freeze / thaw conditions
 - b. 0 percent for all other conditions
 - 6. Maximum Slump: 4 inches.
 - 7. Maximum Aggregate Size: 3/4 inch.
- I. Normal Weight Fiber Reinforced Concrete
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 4,500 pounds per square inch.
 - 2. Fly Ash Content: Maximum 15 percent of cementitious materials by weight.
 - 3. Cement Content: Minimum 520 lb per cubic yard.
 - 4. Water-Cement Ratio: Maximum 45 percent by weight.
 - 5. Total Air Content: 0 percent (no entrained air)
 - 6. Maximum Slump: 4 inches.
 - 7. Maximum Aggregate Size: 3/4 inch.
 - 8. Mix design shall comply within limits for Shrinkage (Length Change).
 - 9. Add synthetic fiber reinforcement into concrete mixer before, during, or after batching other concrete materials.
 - a. Application Rate: Minimum of 1.5 pounds per cubic yard of concrete.

2.09 MIXING

- A. On Project Site: Mix in drum type batch mixer, complying with ASTM C685. Mix each batch not less than 2 minutes.
 - 1. Fiber Reinforcement: Batch and mix as recommended by manufacturer for specific project conditions.
- B. Transit Mixers: Comply with ASTM C94/C94M.
- C. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

1. Concrete supplier shall provide allowable volumetric water addition prior to delivery that does not exceed specified water-cement ratio.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 PREPARATION

- A. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- B. Construction Joints:
 1. Submit proposed construction joint locations and sequencing for Engineer approval.
 2. Spacing of joints shall follow spacings specified on Drawings and below requirements.
 3. Joint Location: Any deviations to be approved by Engineer.
 - a. Column and Walls: Wall shall be poured monolithically the full height as shown on the Drawings. Walls shall be divided into wall pour lengths as shown on the Drawings. Joints at corners to be located as shown on the Drawings.
 - b. Mat Foundation Slabs: Slab shall be divided into approximate squares with maximum joint spacing as shown on Drawings.
 - c. Beams and Girders: Joints shall be located within the middle third of the span. At beam intersections, joints must be offset a minimum of twice the beam width.
 - d. Suspended Slabs: Joints shall be located within the middle third of the span. Locate joints into approximate squares with a maximum joint spacing of 40 feet.
- C. Abutting sections of concrete elements shall not be placed within a 48 hour period.
- D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in according to bonding agent manufacturer's instructions.
 1. Use latex bonding agent only for non-load-bearing applications.
- E. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches (150 mm). Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.

1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI PRC-304.
- B. Place concrete for floor slabs in accordance with ACI PRC-302.1.
- C. Notify Engineer not less than 24 hours prior to commencement of placement operations.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- E. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- F. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- G. Pumping systems used to convey concrete shall limit slump loss to not exceed 1 inch. The slump loss shall be determined by tests made at each end of the pumping system.
- H. Concrete shall be placed so that segregation does not occur. Downpipes or tremies shall be used to place concrete as close to its final destination as possible.
 1. Concrete's free fall should not exceed 4 feet.
- I. Concrete is to be placed in horizontal uniform layers not to exceed 24 inches. Consolidate concrete by mechanically vibrating.
- J. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.04 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. An independent testing agency, as specified in Section 01 45 00, will inspect finished slabs for conformance to specified tolerances.
- B. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
 1. Exposed to View and Foot and Vehicle Traffic: F(F) of 25; F(L) of 20.

- C. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155/E1155M, within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- D. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than $F(F) \frac{13}{F(L) 10}$.
- E. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.05 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch (6 mm) or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch (6 mm) or more in height. Provide finish as follows:
 - 1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal. The rubbing shall remove all form marks and surface irregularities and provide a smooth texture and uniform color.
 - a. Schedule:
 - 1) All exposed surfaces not listed under "Grout Clean Finish"
 - 2. Coordinate with Architectural plans.
 - 3. Grout Cleaned Finish: Prepare surface as described in "Smooth Rubbed Finish". Wet the surface and apply grout mixture by brush or spray. Immediately after applying grout mix, scrub grout coat surface and fill remaining air voids. After drying, rub vigorously with clean burlap, and keep moist for 36 hours.
 - a. Schedule:
 - 1) Main Level exposed wall surfaces (excluding water containment basins)
- D. Concrete Slabs: All slab finishes must be verified with Engineer prior to concrete placement. Finish to requirements of ACI 302.1R, and as follows:
 - 1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in ACI PRC-302.1; thick floor coverings include quarry tile, ceramic tile, and Portland cement terrazzo with full bed setting system.
 - 2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI PRC-302.1; thin floor coverings include carpeting, resilient flooring,

seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.

3. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.
4. Exterior Concrete Slabs: "Steel trowel with light broomed surface" as described in ACI 302.1R.

- E. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains as indicated on drawings.

3.06 CURING AND PROTECTION

- A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

1. Normal concrete: Not less than seven days.

- C. Formed Surfaces:

1. Initial Curing: Start as soon as forms have been removed. Keep continuously moist for not less than seven days by saturated burlap or water-fog spray.
 - a. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 7 days.
 - b. Spraying: Spray water over floor slab areas and maintain wet.
 - c. Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place.

- D. Surfaces Not in Contact with Forms:

1. Slabs and Floors To Receive Epoxy Coated Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than seven days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
 - a. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for 7 days.
 - b. Spraying: Spray water over floor slab areas and maintain wet.

- c. Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place.
- 3. Final Curing: Begin after initial curing but before surface is dry.
 - a. Moisture-Retaining Sheet: Lap strips not less than 3 inches (75 mm) and seal with waterproof tape or adhesive; secure at edges.

3.07 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements 01 45 00 - Quality Control.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure five concrete test cylinders.
 - 1. Sample frequency: Obtain test samples for every concrete pour greater than five (5) cubic yards. Additionally obtain test samples for every 50 cu yd of concrete placed.
 - 2. Test cylinders to be tested at the following age: One (1) at 7 days, three (3) at 28 days, and one (1) at 54 days.
 - 3. Additional concrete cylinders to be tested at days other than those specified above must be requested by the Contractor. Costs of additional cylinders will be by the Contractor.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- H. Perform one air test for each set of test cylinders taken. Air content shall be tested per ASTM C231. Concrete tested for air shall be sampled for at the point of discharge where pumping is being used.
- I. Take and record temperature of all concrete tested.
- J. Maintain records of concrete placement. Record date, location, time truck left plant, time truck started emptying, time truck empty, quantity, air temperature, and test samples taken.

- K. Test completed water bearing structures as specified. Patch and repair completed structures as required to meet specified requirements.

3.08 PATCHING AND REPAIR

- A. Allow Engineer to observe concrete surfaces immediately upon removal of forms. Patch imperfections as specified in Section 03 01 00 per manufacturer's instructions. Areas patched prior to Engineer's observation and concurrence will require removal of patching material to allow observation. Costs associated with removal and replacement shall be paid by the Contractor.

3.09 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances, or specified requirements.
- C. If concrete tests fail to meet required strength, additional tests will be directed by Engineer. If additional tests fail to confirm required strength, the Contractor shall pay for all the cost of Work to replace defective concrete. Contractor shall pay for all additional tests and engineering services.
- D. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- E. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

3.10 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.
- B. Do not allow construction loads in excess of final design loads on any structural concrete members without shoring and possible re-shoring.

END OF SECTION 03 30 00

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SECTION 03 35 43

POLISHED CONCRETE FINISHING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes polished concrete finishing.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each type of product requiring color selection.

1.03 QUALITY ASSURANCE

- A. Field Sample Panels: After approval of samples, produce field sample panels to demonstrate the approved range of selections made under Sample submittals. Produce a minimum of three sets of full-scale panels, approximately 48 by 48 inches (1200 by 1200 mm) minimum, to demonstrate the expected range of finish, color, and appearance variations.
 - 1. Locate panels as indicated or, if not indicated, as directed by Architect.
 - 2. Maintain field sample panels during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Demolish and remove field sample panels when directed.

PART 2 - PRODUCTS

2.01 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatments for Polished Concrete Finish: Clear, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; that penetrates, hardens, and is suitable for polished concrete surfaces.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide PROSOCO, Inc; Consolideck LS or a comparable product by one of the following:
 - a. L&M Construction Chemicals, Inc; FGS Hardener Plus.
 - b. Scofield, L. M. Company; SelectSeal Plus.

PART 3 - EXECUTION

3.01 POLISHING

- A. Grinding level: Medium Aggregate blend for Aggregate Exposure.
 - 1. According to manufacturer's written instructions for sealing and staining system.
- B. Polish: Level 2: Low sheen, 400 grit.
 - 1. Exposure of aggregate beyond CPAA Class D-Large Aggregate is not acceptable.
- C. Apply polished concrete finish system to cured and prepared slabs.
 - 1. Machine grind floor surfaces to receive polished finishes level and smooth.
 - 2. Apply reactive stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
 - 3. Apply penetrating liquid floor treatment for polished concrete in polishing sequence and according to manufacturer's written instructions, allowing recommended drying time between successive coats.
 - 4. Apply penetrating stain for polished concrete in polishing sequence and according to manufacturer's written instructions.
 - 5. Continue polishing with progressively finer-grit diamond polishing pads to gloss level, to match approved mockup.
 - 6. Control and dispose of waste products produced by grinding and polishing operations.
 - 7. Neutralize and clean polished floor surfaces.

END OF SECTION

SECTION 03 41 13
PRECAST CONCRETE HOLLOW CORE PLANKS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Precast floor and roof planks.
- B. Connection plates with brackets and hangers.
- C. Grouting plank joint keys.

1.02 RELATED REQUIREMENTS

- A. Section 03 30 00 - Cast-in-Place Concrete.
- B. Section 03 41 13 - Precast Concrete Hollow Core Planks .

1.03 REFERENCE STANDARDS

- A. ACI CODE-318 - Building Code for Structural Concrete—Code Requirements and Commentary; 2025.
- B. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- E. ASTM A416/A416M - Standard Specification for Low-Relaxation, Seven-Wire Steel Strand for Prestressed Concrete; 2026.
- F. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2026.
- G. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- H. AWS B2.1/B2.1M - Specification for Welding Procedure and Performance Qualification; 2021, with Errata (2023).
- I. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Errata (2026).
- J. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).

- K. IAS AC157 - Accreditation Criteria for Fabricator Inspection Programs for Reinforced and Precast/Prestressed Concrete; 2024, with Editorial Revision (2025).
- L. PCI (CERT) - PCI Plant Certification; Current Edition.
- M. PCI MNL-116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products; 2021.
- N. PCI MNL-120 - PCI Design Handbook; 2025.
- O. PCI MNL-123 - Connections Manual: Design and Typical Details of Connections for Precast and Prestressed Concrete; 1988.
- P. PCI MNL-124 - Design for Fire Resistance of Precast Prestressed Concrete; 2011.
- Q. PCI MNL-126 - PCI Manual for the Design of Hollow Core Slabs and Walls; 2015.
- R. PCI MNL-135 - Tolerance Manual for Precast and Prestressed Concrete Construction; 2000.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate location of hanger tabs and devices for mechanical and electrical work and cutting of field openings.
- B. Preinstallation Meeting: Convene 14 days before starting work of this section.
 - 1. Discuss anchor and weld plate locations, sleeve locations, and cautions regarding cutting or core drilling.

1.05 SUBMITTALS

- A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
- B. Product Data: Indicate standard component configuration, design loads, deflections, and cambers.
- C. Shop Drawings: Indicate plank locations, unit identification marks, connection details, edge conditions, bearing requirements, support conditions, dimensions, openings, openings intended to be field cut, and relationship to adjacent materials.
- D. Fabricator's Qualification Statement: Provide documentation showing precast concrete fabricator is accredited by PCI.

1.06 QUALITY ASSURANCE

- A. Single Source Requirement: Provide precast concrete of this section and the following sections by one supplier. Supplier may use other manufacturers for specific products, but submittals and coordination for all precast products shall be the responsibility of a single supplier:
 - 1. Section 03 41 13 - Precast Concrete Hollow Core Planks.
- B. Designer Qualifications: Design precast concrete hollow core planks under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
- C. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience and PCI certified.
- D. Erector Qualifications: Company specializing in performing the type of work specified in this section, with minimum 3 years of documented experience and PCI certified.
- E. Welding Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.4/D1.4M and no more than 12 months before start of scheduled welding work.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Lifting or Handling Devices: Capable of supporting member in positions anticipated during manufacture, storage, transportation, and erection.
- B. Mark each member with date of production and final position in structure.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Precast Concrete Hollow Core Planks:
 - 1. See Suppliers listed in 03 45 00 Precast Architectural Concrete

2.02 PRECAST UNITS

- A. Precast Hollow Core Planks: Comply with PCI MNL-120, PCI MNL-126, PCI MNL-124 ACI CODE-318, and ACI SPEC-301.
 - 1. Dimensions as indicated on drawings.
 - 2. Design components to withstand dead loads and design loads in the configuration indicated on drawings and as follows:
 - a. Maximum Allowable Deflection of Roof Planks: 1/240 of span.
 - 3. Design connections in accordance with PCI MNL-123.

4. Design components to accommodate construction tolerances, deflection of other building structural members and clearances of intended openings.
5. Grouted Keys: Capable of transmitting horizontal shear force of _____ pounds per linear foot (_____ kg/m).
6. Fire Resistance: Design planks in accordance with PCI MNL-124 to achieve hourly ratings as follows:
 - a. See architectural drawings for all fire rating requirements.

2.03 MATERIALS

- A. Concrete Materials: ACI SPEC-301.
- B. Tensioning Steel Tendons: ASTM A416/A416M, Grade 250 - 250K psi (1725 MPa); seven-wire stranded steel cable; low-relaxation type; full length without splices; weldless; uncoated.
- C. Reinforcing Steel: ASTM A615/A615M, Grade 40 (40,000 psi) (280 MPa) deformed steel bars.
- D. Non-Shrink Grout: Non-metallic, minimum compressive strength of 10,000 psi (69 MPa) at 28 days.
- E. Cement Grout: Minimum compressive strength of 5,000 psi (34.5 MPa) at 28 days.

2.04 ACCESSORIES

- A. Connecting and Supporting Devices: Plates, angles, items cast into concrete, items connected to steel framing members, and inserts: ASTM A666 stainless steel; no. 1 hot-rolled, annealed, and descaled finish.
- B. Core Hole End Plugs: Cardboard insert with stiff concrete fill.
- C. Bearing Pads: High density plastic, 1/8 inch (3 mm) thick, smooth on one side. Vulcanized elastomeric compound molded to size.
- D. Sill Seal: Compressible glass fiber strips.

2.05 FABRICATION

- A. Embed anchors, inserts, plates, angles, and other items at locations indicated.
- B. Provide openings required by other sections, at locations indicated.
- C. Cut exposed ends recessed for grout fill of stressing tendons.
- D. Plant Finish: PCI MNL-116.

1. Roof Members: Finish B Grade.
 2. Floor Members: Finish B Grade.
- E. Connecting and Supporting Steel Devices: Do not paint surfaces in contact with concrete or surfaces requiring field welding.

2.06 FABRICATION TOLERANCES

- A. Comply with PCI MNL-116 and PCI MNL-135, except as specifically amended below.
1. Maximum Variation From Nominal Dimensions:
 - a. Width: Plus or minus 1/4 in (6 mm).
 - b. Length: Plus or minus 1/2 in (12 mm).
 - c. Depth: Plus or minus 1/4 in (6 mm).
 2. Maximum Variation From Intended Camber: Plus or minus 1/4 inch in 10 feet (2 mm per m).
 3. Maximum Variation from Plan End Squareness: Plus or minus 1/4 in (6 mm).
 4. Maximum Sweep: Plus or minus 1/4 in (6 mm).
 5. Maximum Misalignment of Anchors, Inserts, Openings: Plus or minus 1/8 inch (3 mm).
 6. Maximum Bowing of Members: Length/360.
 7. Maximum Bowing of Members: Plus or minus 1/4 inch in 10 feet (2 mm per m) to a maximum of 3/8 inch (10 mm).

2.07 SOURCE QUALITY CONTROL

- A. See Section 03 30 00 for testing of concrete and grout, materials, and mix designs.
- B. Produce planks in accordance with requirements of PCI MNL-116. Maintain plant records and quality control program during production of precast planks. Make records available upon request.
- C. Inspect and test stressing tendons before delivery for compliance with specified standards.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that site conditions are ready to receive work and field measurements are as indicated on shop drawings.

3.02 PREPARATION

- A. Prepare support devices for the erection procedure and temporary bracing.

3.03 ERECTION

- A. Erect members without damage to structural capacity, shape, or finish. Replace or repair damaged members.
- B. Install bearing pads and sill seal at bearing ends of planks as indicated.
- C. Align and maintain uniform horizontal and end joints, as erection progresses.
- D. Maintain temporary bracing in place until final connection is made. Protect members from staining.
- E. Adjust differential camber between precast members to tolerance before final attachment and grouting.
- F. Adjust differential elevation between precast members to tolerance before final attachment.
- G. Secure units in place. Perform welding in accordance with AWS D1.1/D1.1M.
- H. Grout longitudinal keys as indicated.
- I. Tape seal underside of plank joints to prevent grout leakage.
- J. Make plank-to-plank joints smooth using grout, troweled smooth. Transition differential elevation of adjoining planks with grout to a maximum slope of 1:12.

3.04 TOLERANCES

- A. Erect members level and plumb within allowable tolerances. Comply with PCI MNL-135, except as specifically amended below.
 - 1. Plan Location from Building Grid Datum: Plus or minus 3/4 in (19 mm).
 - 2. Top Elevation from Building Elevation Datum at Plank Ends: Plus or minus 1/2 inch (12.5 mm).
 - 3. Maximum Jog in Alignment of Matching Ends: Plus or minus 1/2 inch (12.5 mm).
 - 4. Exposed Joint Dimension: Plus or minus 3/8 inch (9 mm).
 - 5. Differential Top Elevation As Erected: Plus or minus 3/8 inch (9 mm).
 - 6. Bearing Length in Span Direction: Plus or minus 3/8 inch (9 mm).
 - 7. Differential Bottom Elevation of Exposed Planks: Plus or minus 3/16 inch (4.5 mm).

3.05 PROTECTION

- A. Protect members from damage caused by field welding or erection operations.

3.06 CLEANING

- A. Clean weld marks, dirt, and blemishes from surface of exposed members.

END OF SECTION 03 41 13

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SECTION 03 96 90
WATER TIGHTNESS TEST OF HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Water tightness testing of concrete structures subjected to hydrostatic pressure.
- B. Definition: Leakage is the liquid volume loss based on the measured wetted surface area and depth of water sections.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.
- C. Division 07 - Thermal and Moisture Protection.
- D. Division 09 - Finishes.
- E. Division 11 - Process Piping.

1.03 REFERENCE STANDARDS

- A. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- B. ACI 350.1 - Tightness Testing of Environmental Engineering Concrete Structures.

1.04 SUBMITTALS

- A. See Division 01.
- B. Contractor shall submit a detailed plan outlining the testing sequence to the Engineer 21 days prior to commencing any test.
- C. Submit results of each water tightness test. Results shall indicate:
 - 1. Allowable loss of water volume.
 - 2. Measured loss of water volume.
 - 3. Water temperature at start and end of test.
 - 4. Change in level at a minimum of two locations within structure.
 - 5. Average change in level.
 - 6. Corrections for precipitation and / or evaporation.
 - 7. Corrected change in level.

1.05 QUALITY ASSURANCE

- A. Perform water tightness test in conformance to all requirements of ACI 350.1-10 published by the American Concrete Institute.
- B. Job Conditions:
 - 1. Coordinate timing and procedures for obtaining testing water and structure testing with Owner a minimum of 14 days prior to test.
 - 2. Coordinate timing of testing with other related work, including but not limited to backfilling, disinfection, cleaning, and damp proofing.
 - 3. Concrete slabs supporting tops of walls of hydraulic structures must be complete prior to testing.
 - 4. All leakage testing shall be performed to the satisfaction of the Engineer prior to the installation of damp proofing (if specified to receive damp proofing).

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Owner will furnish water. Water shall be obtained at a time, rate of flow, and location approved by the Owner.
- B. Contractor shall furnish and install all temporary measures necessary to deliver water to the structure, as well as wasting, using or otherwise disposing of, the test water upon completion of testing.

PART 3 - EXECUTION

3.01 GENERAL

- A. The testing of reinforced concrete tanks or water containment structures shall conform to ACI 350.1 and as specified herein.

3.02 PREPARATION

- A. Thoroughly clean the structure to be tested of dirt, mud, and construction debris prior to initiating water tightness test. The floor and sumps shall be flushed with water to provide a clean surface, ready for testing.
- B. Inspect the structure to be tested for potential leakage paths, such as cracks, voids, honeycombing, etc. and repair such patch in compliance with the provisions specified or approved by the engineer.
- C. Contractor shall verify all seals around valves and / or gates and reset or seal as approved by the Engineer. Estimates of gate or valve leakage will not be allowed as adjustments to the measured leakage.

- D. Inlet and outlet pipes not required to be functional may be temporarily plugged prior to conducting leakage test.
- E. No backfill shall be placed against the walls of the containment structures to be tested, unless noted otherwise.
- F. Structural slabs at tops of walls shall be installed to design strength prior to water tightness testing unless express given express written consent from Engineer.

3.03 TESTING PROCEDURES

A. Conditions of Testing:

- 1. Perform tightness testing in conformance with Section 2 of ACI 350.1 (hydrostatic test [HST]).
- 2. Do not begin initial filling of concrete structures until all concrete elements have attained the design compressive strength of the concrete, nor less than 14 days after all concrete walls and base slabs have been placed.
- 3. Initial filling rate, water depth, and waiting period shall conform to the requirements of ACI350.1.
- 4. Test water level to be determined by the maximum design water level shown on the drawings or one inch below a fixed overflow level.
- 5. Unlined concrete containment structures shall be kept full to the level specified for at least three days before testing procedures begin.

B. Testing Procedures:

- 1. Part 1 - Qualitative Criteria:
 - a. The exterior surfaces of the containment structure shall be observed by the Contractor with final acceptance from the Engineer.
- 2. Part 2 - Quantitative Criteria:
 - a. Duration of the test shall not be less than that required for a drop in water surface of 3/8 inch based on the calculated maximum allowable leakage rate but need not exceed 5 days.
 - b. Loss of volume measurements shall be taken at 24 hour intervals. The loss of volume is typically determined by measuring the drop in water surface elevation and computing change in volume of the contained water. Measure water surface elevation at not less than two location at 180 degrees apart (or opposite corners of square and rectangular tanks) and preferably at four location 90 degrees apart.

C. Reports:

- 1. Submit to the Engineer water tightness test results for each structure tested. Reports shall include information specified herein.

2. Notify the Engineer of the scheduling of tests 3 working days prior to the tests. The Engineer may monitor any water tightness testing performed on the structure.
- D. Provide all measures necessary to remove all test medium and properly clean and disinfect structure prior to commencing startup activities.

3.04 ACCEPTANCE

- A. Part 1 - Qualitative Criterion: The following conditions shall be considered as not meeting the criteria for acceptance regardless of the actual loss of water volume from the structure:
 1. Ground water leakage into the structure.
 2. Structure which exhibit water flowing from the tank or from beneath the foundation.
 3. Structures on which wet spots or other apparent seepage is visible on the exterior surface.
- B. Part 2 - Quantitative Criterion: The water tightness of concrete tanks and structures shall be considered acceptable when loss of water volume is within the criteria listed below:
 1. For structures with floors that are monolithically placed and designed to be shrinkage crack free, loss of volume not exceeding 0.0125 percent in 24 hours.
 2. For reinforced concrete tanks with fully lined walls, loss of volume shall exhibit no measurable properties.

3.05 REPAIRS AND RETESTING

- A. Structures failing the water tightness test and not exhibiting visible leakage may be retested after an additional stabilization period of not less than 3 days. Tanks failing this second test shall be repaired prior to further testing.
- B. Repair structures which fail the water tightness test and structures showing visible leakage in compliance with the provisions specified herein or as approved by the Engineer.
- C. If structure is backfilled prior to performing tests, excavate material as needed to assess and repair leaks.
- D. Repairs and retesting of tanks shall be completed at no additional cost to the Owner.

3.06 SCHEDULE

- A. SBR & PTB Structures: Individual basins to be tested independently:

END OF SECTION 03 96 90

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DIVISION 05

METALS

SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Structural steel framing members.
- B. Structural steel support members and struts.
- C. Base plates, shear stud connectors.

1.02 RELATED REQUIREMENTS

1.03 REFERENCE STANDARDS

- A. AISC (MAN) - Steel Construction Manual; 2023, with Errata (2026).
- B. AISC 303 - Code of Standard Practice for Steel Buildings and Bridges; 2022, with Errata (2025).
- C. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2019.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- E. ASTM A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished; 2024.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- G. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- H. ASTM A307 - Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength; 2021.
- I. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength; 2014.
- J. ASTM A490 - Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength; 2014a.
- K. ASTM A490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric); 2014a.

- L. ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes; 2023.
- M. ASTM A501/A501M - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing; 2021.
- N. ASTM A992/A992M - Standard Specification for Structural Steel Shapes; 2022.
- O. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable; 2026.
- P. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2025.
- Q. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2020.
- R. ASTM E94 - Standard Guide for Radiographic Examination; 2004 (Reapproved 2010).
- S. ASTM E94/E94M - Standard Guide for Radiographic Examination Using Industrial Radiographic Film; 2022.
- T. ASTM E164 - Standard Practice for Contact Ultrasonic Testing of Weldments; 2024.
- U. ASTM E165/E165M - Standard Practice for Liquid Penetrant Testing for General Industry; 2023.
- V. ASTM E709 - Standard Guide for Magnetic Particle Testing; 2021.
- W. ASTM F436 - Standard Specification for Hardened Steel Washers; 2011.
- X. ASTM F959 - Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners; 2013.
- Y. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength; 2020.
- Z. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination; 2020.
- AA. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2025, with Errata (2026).
- BB. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172; 2019, with Editorial Revision (2025).

- CC. RCSC (HSBOLT) - Specification for Structural Joints Using High-Strength Bolts; Research Council on Structural Connections; 2020.
- DD. SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic); 2019.
- EE. SSPC-SP 3 - Power Tool Cleaning; 2024.

1.04 SUBMITTALS

- A. See Division 01.
- B. Shop Drawings:
 - 1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
 - 2. Connections not detailed.
 - 3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
- C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
- D. Fabricator's Qualification Statement: Provide documentation showing steel fabricator is accredited under IAS AC172 or the AISC certification program.

1.05 QUALITY ASSURANCE

- A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."
- B. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel (AC172) or accredited by the AISC certification program.
- C. Erector: Company specializing in performing the work of this section with minimum five years of documented experience.
- D. Design connections not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Steel Angles and Plates: ASTM A36/A36M.
- B. Steel W Shapes and Tees: ASTM A992/A992M.

- C. Rolled Steel Structural Shapes: ASTM A992/A992M.
- D. High-Strength Structural Bolts, Nuts, and Washers: ASTM A325 (ASTM A325M), Type 1, medium carbon, plain or galvanized (match adjacent finish).
- E. Headed or Threaded and Nuted Anchor Rods: ASTM F1554, Grade 36, plain, with matching ASTM A563 or A563M nuts and ASTM F436 Type 1 washers.
- F. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
- G. Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.
- H. Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

2.02 FABRICATION

- A. Shop fabricate to greatest extent possible.
- B. Continuously seal joined members by continuous welds. Grind exposed welds smooth.
- C. Fabricate connections for bolt, nut, and washer connectors where possible. Indicate sizes and locations of field welds on shop drawings.
- D. Develop required camber for members.

2.03 FINISH

- A. Prepare structural component surfaces in accordance with SSPC-SP 3.
- B. Shop prime structural steel members unless noted on the drawings to be galvanized. Do not prime surfaces that will be fireproofed, field welded, or in contact with concrete.
- C. Galvanize structural steel members as indicated on the drawings and all steel members embedded or in contact with concrete to comply with ASTM A123/A123M. Provide minimum 1.7 oz/sq ft galvanized coating. (Provide minimum 530 g/sq m galvanized coating.)

2.04 SOURCE QUALITY CONTROL

- A. Welded Connections: Visually inspect all shop-welded connections and test at least 50 percent of full penetration welds using one of the following:
 - 1. Radiographic testing performed in accordance with ASTM E94/E94M.
 - 2. Ultrasonic testing performed in accordance with ASTM E164.

3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.
4. Magnetic particle inspection performed in accordance with ASTM E709.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.02 ERECTION

- A. Erect structural steel in compliance with AISC 303.
- B. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
- C. Field weld components indicated on shop drawings.
- D. Use carbon steel bolts only for temporary bracing during construction, unless otherwise specifically permitted on drawings. Install high-strength bolts in accordance with RCSC (HSBOLT) "Specification for Structural Joints Using High-Strength Bolts".
- E. Do not field cut or alter structural members without approval of Architect.
- F. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

3.03 TOLERANCES

- A. Maximum Variation From Plumb: 1/4 inch (6 mm) per story, non-cumulative.
- B. Maximum Offset From True Alignment: 1/4 inch (6 mm).

3.04 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 45 00 .
- B. High-Strength Bolts: Provide testing and verification of field-bolted connections in accordance with AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts", testing at least 100 percent of bolts at all fully tensioned connection.
- C. Welded Connections: Visually inspect all field-welded connections and test at least 100 percent of full penetration welds using one of the following:
 1. Radiographic testing performed in accordance with ASTM E94/E94M.

2. Ultrasonic testing performed in accordance with ASTM E164.
3. Liquid penetrant inspection performed in accordance with ASTM E165/E165M.
4. Magnetic particle inspection performed in accordance with ASTM E709.

END OF SECTION 05 12 00

SECTION 05 50 00

METAL FABRICATIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Shelf angles.
3. Loose bearing and leveling plates.
4. Miscellaneous steel trim.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
3. Steel weld plates and angles for casting into concrete.

PART 2 - PRODUCTS

2.01 METALS

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- D. Rolled-Steel Floor Plate: ASTM A786/A786M, rolled from plate complying with ASTM A36/A36M or ASTM A283/A283M, Grade C or D.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.

2.02 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
 - 1. Provide stainless steel fasteners for fastening aluminum.
 - 2. Provide bronze fasteners for fastening bronze.
- B. Cast-in-Place Anchors in Concrete: Either threaded or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329/F2329M.
- C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1 stainless steel bolts, ASTM F593 (ASTM F738M), and nuts, ASTM F594 (ASTM F836M).
- D. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches (41 by 22 mm) by length indicated with anchor straps or studs not less than 3 inches (75 mm) long at not more than 8 inches (200 mm) o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

2.03 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099001 "Painting" and Section 099002 "High-Performance Coatings."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Water-Based Primer: Emulsion type, anticorrosive primer for mildly corrosive environments that is resistant to flash rusting when applied to cleaned steel, complying with MPI#107 and compatible with topcoat.
- D. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.

- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- H. Shrinkage-Resistant Grout: Factory-packaged, nonmetallic, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- I. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

2.04 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. Weld corners and seams continuously to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing.
- F. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- G. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

- H. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c.

2.05 MISCELLANEOUS FRAMING AND SUPPORTS

- A. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
- B. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.
 - 1. Where wood nailers are attached to girders with bolts or lag screws, drill or punch holes at 24 inches (600 mm) o.c.
- C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.06 SHELF ANGLES

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch (19-mm) bolts, spaced not more than 6 inches (150 mm) from ends and 24 inches (600 mm) o.c., unless otherwise indicated.
 - 1. Provide mitered and welded units at corners.
 - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches (50 mm) larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize and prime all shelf angles.
- D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.07 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.

- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.

2.08 LOOSE BEARING AND LEVELING PLATES

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize bearing and leveling plates.

2.09 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.
- B. Galvanize loose steel lintels located in exterior walls.

2.10 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

2.11 GENERAL FINISH REQUIREMENTS

- A. Finish metal fabrications after assembly.

2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.

- C. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
1. Exterior Items: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 3. Items Indicated to Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 4. Other Steel Items: SSPC-SP 3, "Power Tool Cleaning."
 5. Galvanized-Steel Items: SSPC-SP 16, "Brush-off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.
 3. Remove welding flux immediately.
 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

3.02 INSTALLATION OF MISCELLANEOUS FRAMING AND SUPPORTS

- A. Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for overhead doors securely to, and rigidly brace from, building structure.
- C. Anchor shelf angles securely to existing construction per structural engineer's requirements.
- D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

3.03 INSTALLATION OF BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with shrinkage-resistant grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.04 REPAIRS

- A. Touchup Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

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SECTION 05 51 19

METAL GRATING STAIRS AND RAILINGS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Industrial Class stairs with steel-grating treads.
2. Steel railings and guards attached to metal stairs and other elevated platforms.
3. Steel handrails attached to walls adjacent to metal stairs.
4. Aluminum stairs, railings, guards and gratings.

B. Where aluminum stairs are indicated on drawings, fabricate stairs, railings, guards and gratings using aluminum components in similar fashion as specified for steel stairs and meeting the same performance requirements.

1.02 COORDINATION

A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

1.03 ACTION SUBMITTALS

A. Product Data: For metal grating stairs and the following:

1. Gratings.
2. Grout.

B. Shop Drawings:

1. Include plans, elevations, sections, details, and attachment to other work.
2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
3. Include plan at each level.
4. Indicate locations of anchors, weld plates, and blocking for attachment of wall-mounted handrails.

C. Delegated-Design Submittal: For stairs, railings, and guards, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed in the jurisdiction in which Project is located.
- B. Welding certificates.

1.05 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design stairs, railings, and guards, including attachment to building construction.
- B. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft. (4.79 kN/sq. m).
 - 2. Concentrated Load: 300 lbf (1.33 kN) applied on an area of 4 sq. in. (2580 sq. mm).
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing and guard loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to L/360.
- C. Structural Performance of Railings and Guards: Railings and guards, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ft. (0.73 kN/m) applied in any direction.
 - b. Concentrated load of 200 lbf (0.89 kN) applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
 - 2. Infill of Guards:

- a. Concentrated load of 50 lbf (0.22 kN) applied horizontally on an area of 1 sq. ft. (0.093 sq. m).
 - b. Infill load and other loads need not be assumed to act concurrently.
3. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

2.02 METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Bars for Grating Treads: ASTM A36/A36M or steel strip, ASTM A1011/A1011M or ASTM A1018/A1018M.
- C. Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.
- D. Aluminum Extrusions: ASTM B 221, Alloy 6063-T6.
- E.
- F. Aluminum Bars for Grating Treads: ASTM B221 (ASTM B221M) extruded aluminum, alloys as follows:
 1. 6061-T6 or 6063-T6, for bearing bars of gratings and shapes.
 2. 6061-T1, for grating crossbars.
- G. Steel Tubing for Railings and Guards: ASTM A500/A500M (cold formed) or ASTM A513/A513M.
- H. Steel Pipe for Railings and Guards: ASTM A53/A53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
- I. Provide galvanized finish for all installations where aluminum is not indicated.

2.03 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 for steel stairs and Type 304 stainless steel fasteners for aluminum stairs.
 1. Select fasteners for type, grade, and class required.
- B. Fasteners for Anchoring Railings and Guards to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings and guards to other types of construction indicated and capable of withstanding design loads.

- C. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
 - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
 - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

2.04 MISCELLANEOUS MATERIALS

- A. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with ASTM A780/A780M and compatible with paints specified to be used over it.
- C. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

2.05 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, railings, guards, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs, railings, and guards in shop to greatest extent possible.
 - 1. Disassemble units only as necessary for shipping and handling limitations.
 - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
 - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated.
 - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.

- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
 - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
 - 2. Locate joints where least conspicuous.
 - 3. Fabricate joints that are exposed to weather in a manner to exclude water.
 - 4. Provide weep holes where water may accumulate internally.

2.06 FABRICATION OF STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Industrial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Fabricate stringers of steel channels.
 - a. Stringer Size: As required to comply with "Performance Requirements" Article.
 - b. Provide closures for exposed ends of channel stringers.
 - c. Finish: Galvanized.
 - 2. Construct platforms and tread supports of steel plate or channel headers and miscellaneous framing members as required to comply with "Performance Requirements" Article.
 - a. Provide closures for exposed ends of channel framing.
 - b. Finish: Galvanized.
 - 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers.
 - 4. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.
- C. Metal Bar-Grating Stairs: Form treads and platforms to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual."

1. Fabricate treads and platforms from welded steel or pressure-locked steel grating with openings in gratings no more than 3/4 inch (19 mm) in least dimension.
 - a. Surface: Plain.
 - b. Finish: Galvanized.
 2. Fabricate grating treads with rolled-steel floor plate nosing and with steel angle or steel plate carrier at each end for stringer connections.
 - a. Secure treads to stringers with bolts.
 3. Fabricate grating platforms with nosing matching that on grating treads.
 - a. Secure grating to platform framing with bolts.
- D. Risers: Open.
- E. Toe Plates: Provide toe plates around openings and at edge of open-sided floors and platforms, and at open ends and open back edges of treads.
1. Material and Finish: Steel plate to match finish of other steel items.
 2. Fabricate to dimensions and details indicated.

2.07 FABRICATION OF STAIR RAILINGS AND GUARDS

- A. Fabricate railings and guards to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of member, post spacings, wall bracket spacing, and anchorage, but not less than that needed to withstand indicated loads.
1. Rails and Posts: 1-5/8-inch- (41-mm-) diameter top and bottom rails and 1-1/2-inch- (38-mm-) square posts.
 2. Intermediate Rails Infill: 1-5/8-inch- (41-mm-) diameter intermediate rails spaced less than 21 inches clear.
- B. Welded Connections: Fabricate railings and guards with welded connections.
1. Fabricate connections that are exposed to weather in a manner that excludes water.
 - a. Provide weep holes where water may accumulate internally.
 2. Cope components at connections to provide close fit, or use fittings designed for this purpose.
 3. Weld all around at connections, including at fittings.
 4. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 5. Obtain fusion without undercut or overlap.
 6. Remove flux immediately.

7. Finish welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #4 - Good quality, uniform undressed weld with minimal splatter as shown in NAAMM AMP 521.
 8. Aluminum welds: Good quality, uniform undressed weld. Do not grind.
- C. Form changes in direction of railings and guards as follows:
1. By bending, mitering, or by inserting prefabricated elbow fittings.
- D. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required.
1. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- E. Close exposed ends of railing and guard members with prefabricated end fittings.
- F. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated.
1. Close ends of returns unless clearance between end of rail and wall is 1/4 inch (6 mm) or less.
- G. Connect posts to stair framing by direct welding unless otherwise indicated.
- H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work.
1. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 2. For galvanized railings and guards, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
 3. Provide type of bracket with predrilled hole for exposed bolt anchorage and that provides 1-1/2-inch (38-mm) clearance from inside face of handrail to finished wall surface.
- I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports.
1. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.08 FINISHES

- A. Aluminum Finish: Mill.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.

1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
 2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:
1. Exterior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 2. Interior Stairs: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."

PART 3 - EXECUTION

3.01 INSTALLATION OF METAL STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
1. Grouted Baseplates: Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces.
 - a. Clean bottom surface of baseplates.
 - b. Set steel-stair baseplates on wedges, shims, or leveling nuts.
 - c. After stairs have been positioned and aligned, tighten anchor bolts.
 - d. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.
 - e. Promptly pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
 - 1) Neatly finish exposed surfaces; protect grout and allow to cure.
 - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

- E. Fit exposed connections accurately together to form hairline joints.
 - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
 - 2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
 - 3. Comply with requirements for welding in "Fabrication, General" Article.

3.02 INSTALLATION OF RAILINGS AND GUARDS

- A. Adjust railing and guard systems before anchoring to ensure matching alignment at abutting joints with tight, hairline joints.
 - 1. Space posts at spacing indicated or, if not indicated, as required by design loads.
 - 2. Plumb posts in each direction, within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
 - 3. Align rails and guards so variations from level for horizontal members and variations from parallel with rake of stairs for sloping members do not exceed 1/4 inch in 12 feet (6 mm in 3.5 m).
 - 4. Secure posts, rail ends, and guard ends to building construction as follows:
 - a. Anchor posts to steel by welding or bolting to steel supporting members.
 - b. Anchor handrail and guard ends to concrete and masonry with steel round flanges welded to rail and guard ends and anchored with post-installed anchors and bolts.
- B. Attach handrails to wall with wall brackets.
 - 1. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
 - 2. Secure wall brackets to building construction as required to comply with performance requirements.

3.03 REPAIR

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

END OF SECTION

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DIVISION 07 THERMAL AND MOISTURE PROTECTION

SECTION 07 11 13

BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following:
 - 1. Cold-applied, emulsified-asphalt dampproofing.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include recommendations for method of application, primer, number of coats, coverage or thickness, and protection course.

1.03 QUALITY ASSURANCE

- A. Source Limitations: Obtain primary dampproofing materials and primers through one source from a single manufacturer. Provide secondary materials recommended by manufacturer of primary materials.

1.04 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit dampproofing to be performed according to manufacturers' written instructions.
- B. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has cured.

PART 2 - PRODUCTS

2.01 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. ChemMasters Corp.
 - 2. Degussa Building Systems; Sonneborn Brand Products.
 - 3. Gardner Gibson, Inc.

4. Henry Company.
 5. Karnak Corporation.
 6. Koppers Inc.
 7. Malarkey Roofing Products.
 8. Meadows, W. R., Inc.
 9. Tamms Industries, Inc.
- B. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.
- C. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.
- D. VOC Content: 0.25 lb/gal. or less.

2.02 PROTECTION COURSE

- A. Protection Course: Unless perimeter insulation or drain board is indicated on exterior face of foundation, provide unfaced, fan-folded, extruded-polystyrene board insulation, nominal thickness 1/4 inch with compressive strength of not less than 8 psi per ASTM D 1621.

2.03 MISCELLANEOUS MATERIALS

- A. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
- B. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.
- C. Patching Compound: Manufacturer's fibered mastic of type recommended by dampproofing manufacturer.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for surface smoothness and other conditions affecting performance of work.
1. Proceed with dampproofing application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected.
 2. Test for surface moisture according to ASTM D 4263.

3.02 PREPARATION

- A. Protection of Other Work: Mask or otherwise protect adjoining exposed surfaces from being stained, spotted, or coated with dampproofing. Prevent dampproofing materials from entering and clogging weep holes and drains.

- B. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.
- C. Apply patching compound for filling and patching tie holes, honeycombs, reveals, and other imperfections; cover with asphalt-coated glass fabric.

3.03 APPLICATION, GENERAL

- A. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
 - 1. Apply additional coats if recommended by manufacturer or if required to achieve coverages indicated.
- B. Apply dampproofing to footings and foundation walls where opposite side of wall faces building interior.
 - 1. Extend 12 inches onto intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed.
 - 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch-wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.
 - 3. Do not apply Dampproofing to foundation walls indicated to receive Waterproofing.

3.04 COLD-APPLIED, EMULSIFIED-ASPHALT DAMPPROOFING

- A. On Concrete Foundations: Apply 2 brush or spray coats at not less than 1.5 gal./100 sq. ft. for first coat and 1 gal./100 sq. ft. for second coat, 1 fibered brush or spray coat at not less than 3 gal./100 sq. ft., or 1 trowel coat at not less than 4 gal./100 sq. ft..

3.05 INSTALLATION OF PROTECTION COURSE

- A. Where indicated, install protection course over completed-and-cured dampproofing. Comply with dampproofing material manufacturer's written recommendations for attaching protection course.
 - 1. Support protection course with spot application of adhesive of type recommended by protection board manufacturer over cured coating.

3.06 CLEANING

- A. Remove dampproofing materials from surfaces not intended to receive dampproofing.

END OF SECTION

SECTION 07 13 26

SELF-ADHERING SHEET WATERPROOFING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes waterproofing work for elastic sheet waterproofing and protection board.
- B. Locations: All below-grade exterior walls and foundations where interior spaces are occupied by people or equipment and where indicated on the Drawings.

1.02 SUBMITTALS

- A. Product Data: Submit specifications, installation instructions and general recommendations by the manufacturer of waterproofing work, including written instructions for evaluating, preparing and treating substrate.
- B. Samples: Provide the following:
 - 1. 12 inch by 12 inch square of waterproofing sheet
 - 2. 4 inch by 4 inch square of drainage panel

1.03 QUALITY ASSURANCE

- A. Manufacturer: Provide all waterproofing sheet products from a single manufacturer with a proven record of successful experience in supplying waterproofing materials for the required work. Drainage panels, protection boards, and sheet products may be from different manufacturers, subject to compliance with requirements.
- B. Installer: A firm which has specialized in installation of waterproofing, and which is acceptable to manufacturer of the primary waterproofing materials.
- C. Preinstallation Conference: Conduct conference at Project site to review manufacturer's requirements, including surface preparation, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special conditions and flashings, installation procedures, testing and inspection procedures and protection and repairs.

1.04 PROJECT/SITE CONDITIONS

- A. Proceed with waterproofing work only after substrate construction and penetrating work have been completed.

- B. Proceed with waterproofing work only when weather conditions comply with manufacturer's recommendations, and will permit the materials to be applied in accordance with the recommendations of the manufacturer.
- C. Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate, in snow, rain, fog or mist. Maintain adequate ventilation during preparation and application of waterproofing.
- D. Protect stored and installed materials according to manufacturer's written instructions and out of direct sunlight.

1.05 WARRANTY

- A. Provide manufacturer's standard written 5-year warranty issued by the membrane manufacturer, starting from the date of Substantial Completion, agreeing to replace the waterproofing membrane in case of leaks caused by either material or workmanship.

PART 2 PRODUCTS

2.01 WATERPROOFING

- A. Self-adhering, cold-applied membrane of rubberized asphalt integrally bonded to polyethylene sheeting. Provide the following or an approved equal:
 - a. Carlisle Coatings and Waterproofing: "CCW MiraDri 860/861"
 - 2. 60-mil-thick sheet consisting of 56 mils of rubberized asphalt laminated to a 4-mil-thick, polyethylene film with release liner on adhesive side.
 - 3. Tensile strength: 250 psi per ASTM D 412.
 - 4. Ultimate elongation: 300% per ASTM D412.
 - 5. Vapor permeance: 0.05 perms maximum per ASTM E96, Method B.
 - 6. Puncture resistance: 40 lbf minimum per ASTM E 154.
- B. Temperature: If applying waterproofing at temperatures between 25°F and 40°F, use type formulated for that temperature range.
- C. Miscellaneous Materials: Furnish primers, mastics, fillers, sealers, joint tapes, liquid membranes, adhesives and accessories formulated by the membrane manufacturer for actual conditions of use.

2.02 PROTECTION BOARDS:

- A. Fan-folded, with a core of extruded-polystyrene board insulation sandwiched between two sheets of plastic film, nominal thickness of 1/4 inch, with compressive strength of 15 psi per ASTM D 1621 and maximum water absorption by volume of 0.4 percent per ASTM C 272.

1. Tenneco Building Products: "Amocor-PB4"
2. Dow Chemical: "Protection Board"
3. Approved equal

PART 3 EXECUTION

3.01 EXAMINATION

- A. Refer to Division 1 for examination of substrate and job conditions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION OF SUBSTRATE

- A. Clean the substrate of projections and substances detrimental to the work; comply with recommendations of the waterproofing materials manufacturer.
- B. Install fillets, cant strips and similar accessories as shown and as recommended by the prime materials manufacturer even though not shown.
- C. Fill voids, seal joints and apply bond breakers as recommended by the prime materials manufacturer.
- D. Install separate flashing as recommended by the prime materials manufacturer, wherever indicated to precede the membrane or coating.
- E. Comply with details shown and manufacturer's recommendations. Give particular attention to requirements at expansion and control joints.
- F. Prime the substrate as recommended by the prime materials manufacturer.

3.03 INSTALLATION

- A. General: Comply with manufacturer's instructions, except where more stringent requirements are shown or specified, and except where project conditions require extra precautions or provisions to ensure satisfactory performance of the work.
- B. Elastic Sheet Waterproofing Installation:
 1. Install self-adhering sheets according to ASTM D 6135.
 2. Apply primer to cured and dry concrete surfaces per manufacturer's recommendations. Allow to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Re-prime areas exposed for more than 24 hours.

3. Lap sheets and seal joints in the manner recommended by the manufacturer, using not less than 2-1/2 inch lap width and end laps. Overlap and seal seams and stagger end laps to ensure watertight installation.
 4. Remove release paper as sheets are unrolled and applied. Run sheets vertically on vertical and inclined surfaces as recommended by manufacturer, and as shown. Extend sheets with sealed joints to form flashings, as shown and as required to form leak-proof performance. Flash and seal membrane to projections through the substrate.
- C. Protection Boards: Install protection course with butted joints over waterproofing before starting subsequent construction operations.

3.04 REPAIRS

- A. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheets extending 6 inches beyond repaired areas in all directions.

END OF SECTION

SECTION 07 4113 –

METAL ROOF PANELS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Standing-seam metal roof panels.
 - 2. Roof Panel Accessories.

1.2 DEFINITIONS

- A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: Negative 1.57 lbf/sq. ft. (75 Pa).
- C. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 2.86 lbf/sq. ft. (137 Pa).
- D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
 - 1. Uplift Rating: UL 90.
- F. Hail Resistance: UL 2218 Class 4.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.

- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
 - 1. Accessories: Include details of the following items, at a scale of not less than 1 inch per 12 inches (1:12):
 - a. Flashing and trim.
- C. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Metal Roof Panels: 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other metal roof panel accessories.
 - 2. Trim and Closures: 12 inches (300 mm) long. Include fasteners and other exposed accessories.
 - 3. Accessories: 12-inch-(300-mm-) long Samples for each type of accessory.
- D. Warranties: Samples of special warranties.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of metal roof panels from single source from single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to manufacturer's written instructions and warranty requirements.

- B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal roof panels with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- B. Special Weathertightness Warranty: Applicator's standard form in which applicator agrees to repair or replace metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
 - 1. Weathertight Warranty Period: twenty years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 - 2. Surface: Smooth, flat finish.
 - 3. Exposed Coil-Coated Finish:
 - a. Full strength Kynar 500 or Hylar 5000 Fluoropolymer coating, applied by the manufacturer on a continuous coil coating line, with a top side dry film thickness of 0.70 to 0.90 mil over 0.25 to 0.35 mil prime coat, to provide a total dry film thickness of 0.95 to 1.25 mil. Bottom side shall be coated with primer with a dry film thickness of 0.25 mil.

B. Panel Sealants:

1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.2 MISCELLANEOUS MATERIALS

- A. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide bearing plates under clips when applying panels directly to insulation. Provide concealed fasteners whenever possible. When exposed, provide fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- C. Roof Panel Underlayment: ASTM D 1970, minimum 40-mil-thick, self-adhering, polymer-modified, bituminous sheet membrane. Provide primer when recommended by underlayment manufacturer.
 1. "Ice and Water Shield" by W. R. Grace or approved equal.

2.3 STANDING-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
 1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E 1514.
- B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Weather Lok 16 by MBMI Metal Buildings or comparable product by one of the following:
 - a. AEP Span; a BlueScope Steel company.
 - b. Architectural Building Components.
 - c. Berridge Manufacturing Company.

- d. CENTRIA Architectural Systems.
 - e. Fabral.
 - f. Firestone Building Products.
 - g. Metal-Fab Manufacturing, LLC.
 - h. Metal Sales Manufacturing Corporation.
- 2. Joint Type: Double folded.
 - 3. Thickness: 24 gauge.
 - 4. Panel Coverage: 16 inches.
 - 5. Panel Height: 2 inches.

2.4 ACCESSORIES

- A. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
 - 2. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch-(25-mm-) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 3. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
- B. Flashing and Trim: Formed from same material as roof panels, prepainted with coil coating, minimum 0.018 inch (0.45 mm) thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

2.5 FABRICATION

- A. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
2. End Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
3. End Seams for Other Than Aluminum: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
4. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
5. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
6. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.6 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of the Work.
- B. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
- C. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
- D. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.
- B. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written instructions.

3.3 METAL ROOF PANEL INSTALLATION, GENERAL

- A. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
- B. Thermal Movement. Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.
 - 1. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
- C. Install metal roof panels as follows:
 - 1. Field cutting of metal panels by torch is not permitted.
 - 2. Locate and space fastenings in uniform vertical and horizontal alignment.
 - 3. Provide metal closures at rake edges and each side of ridge caps.
 - 4. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
 - 5. Install ridge caps as metal roof panel work proceeds.
 - 6. Install metal flashing to allow moisture to run over and off metal roof panels.
- D. Fasteners:
 - 1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized-steel fasteners for surfaces exposed to the interior.
- E. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- F. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
 - 1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.

- G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
 - 1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
 - 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.4 METAL ROOF PANEL INSTALLATION

- A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
 - 1. Install clips to supports with self-tapping fasteners.
 - 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 - 3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

3.5 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 - 1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
 - 1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 - 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet(3 m) with no joints allowed within 24 inches(600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch(25 mm) deep, filled with mastic sealant (concealed within joints).
- C. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
- C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.7 CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 4113

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SECTION 07 5323

ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING (EPDM)

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. EPDM membrane roofing system, including all components specified.
- B. Comply with the published recommendations and instructions of the roofing membrane manufacturer, at <http://manual.fsbp.com>.
- C. Commencement of work by Contractor shall constitute acknowledgement by Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.02 RELATED REQUIREMENTS

- A. Section 07 6200 - Sheet Metal Flashing and Trim: Formed metal flashing and trim items associated with roofing.
- B. Section 07 7200 - Roof Accessories: Roof hatches, vents, and manufactured curbs.

1.03 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D1079 for definition of terms related to roofing work not otherwise defined in the section.
- B. LTTR: Long Term Thermal Resistance, as defined by CAN-ULC-S770.

1.04 REFERENCE STANDARDS

- A. ASTM C136/C136M - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates; 2014.
- B. ASTM C1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2018a.
- C. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction; 2012 (Reapproved 2017).
- D. ASTM D1621 - Standard Test Method for Compressive Properties Of Rigid Cellular Plastics; 2016.
- E. ASTM D1622/D1622M - Standard Test Method for Apparent Density of Rigid Cellular Plastics; 2014.

- F. ASTM D4637/D4637M - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane; 2015.
- G. ASTM D4811/D4811M - Standard Specification for Nonvulcanized (Uncured) Rubber Sheet Used as Roof Flashing; 2016.
- H. CAN-ULC-S770 - Standard Test Method Determination of L-Term Thermal Resistance Of Closed-Cell Thermal Insulating Foams; 2015.
- I. ISO 9000 - Quality management systems -- Fundamentals and vocabulary; 2015.

1.05 ADMINISTRATIVE REQUIREMENTS

- A. Pre-Installation Conference: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.
 - 1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work.
 - 2. Notify Architect well in advance of meeting.

1.06 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.
 - 2. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.
- C. Samples: Submit samples of at least the following:
 - 1. Sample of roof membrane.
 - 2. Sample of each insulation type.
- D. Shop Drawings: Provide:

1. The roof membrane manufacturer's standard details customized for this project for all relevant conditions, including flashings, base tie-ins, roof edges, terminations, expansion joints, penetrations, and drains.
 2. For tapered insulation, provide project-specific layout and dimensions for each board.
- E. Specimen Warranty: Submit prior to starting work.
- F. Installer Qualifications: Letter from manufacturer attesting that the roofing installer meets the specified qualifications.
- G. Pre-Installation Notice: Copy to show that manufacturer's required Pre Installation Notice (PIN) has been accepted and approved by the manufacturer.

1.07 QUALITY ASSURANCE

- A. Installer Qualifications: Roofing installer shall have the following:
1. Current approval, license, or authorization as applicator by the manufacturer.
 2. Fully staffed office within 100 miles of the job site.
 3. At least five year's experience in installing specified system.
 4. Capability to provide payment and performance bond to building owner.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.
- B. Store materials clear of ground and moisture with weather protective covering.
- C. Keep combustible materials away from ignition sources.

1.09 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Comply with all warranty procedures required by manufacturer, including notifications, scheduling, and inspections.
- C. Warranty: Firestone Limited Warranty covering membrane, roof insulation, and other indicated components of the system, for the term indicated.
1. Limit of Liability: No dollar limitation.
 2. Scope of Coverage: Repair leaks in the roofing system caused by:

- a. Ordinary wear and tear of the elements.
 - b. Manufacturing defect in Firestone brand materials.
 - c. Defective workmanship used to install these materials.
 - d. Hail up to 2 inches in diameter.
- D. Metal Roof Edging with Exposed Decorative Fascia: Provide 20 year warranty for painted finish covering color fade, chalk, and film integrity.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable Manufacturer - Roofing System: Firestone Building Products LLC, Carmel, IN: www.firestonebpco.com/#sle.
- 1. Roofing systems manufactured by others are acceptable provided the roofing system is completely equivalent in materials and warranty conditions and the manufacturer meets the following qualifications:
 - a. Specializing in manufacturing the roofing system to be provided.
 - b. Minimum ten years of experience manufacturing the roofing system to be provided.
 - c. Able to provide a no dollar limit, single source roof system warranty that is backed by corporate assets in excess of one billion dollars.
 - d. ISO 9000 certified.
 - e. Able to provide isocyanurate insulation that is produced in own facilities.
- B. Manufacturer of Insulation and Cover Boards: Same manufacturer as roof membrane.
- C. Manufacturer of Metal Roof Edging: Same manufacturer as roof membrane.
- D. Substitutions: See Section 01 6000 - Product Requirements.
- 1. Submit evidence that the proposed substitution complies with the specified requirements.

2.02 ROOFING SYSTEM DESCRIPTION

- A. Roofing System: Ethylene-propylene-diene-monomer (EPDM) single-ply membrane.
- 1. Membrane Attachment: Loose laid and ballasted.

2. Warranty: Full system warranty; Firestone 15 year Red Shield Limited Warranty covering membrane, roof insulation, membrane accessories, and metal edging and coping.
 3. Slope: Deck is flat, provide slope of 1/4 inch per foot by means of tapered insulation.
 4. Comply with applicable local building code requirements.
 5. Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.
 6. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and FM DS 1-29, and meeting minimum requirements of FM 1-60 wind uplift rating.
- B. Roofing System Components: Listed in order from the top of the roof down:
1. Ballast.
 2. Membrane: Thickness as specified.
 3. Insulation:
 - a. Maximum Board Thickness: 2.6 inches; use as many layers as necessary; stagger joints in adjacent layers.
 - b. Tapered: Slope as indicated; provide minimum R-value at thinnest point; place tapered layer on top.
 - c. Total R-value: 30 continuous insulation plus tapered insulation.
 - d. Top Layer: 2.6" Polyisocyanurate foam board, non-composite; loose-laid, no attachment.
 - e. Bottom Layer: 2.6" Polyisocyanurate foam board, non-composite; loose-laid, no attachment.
 - f. Crickets: Tapered insulation of same type as specified for top layer; slope as indicated.
 4. Vapor Retarder: One layer SBS modified bitumen sheet; self-adhered.
- C. Ballast: Stone over entire roof.
1. Provide stone ballast of adequate size and weight to provide proper protection against wind uplift and as required by roofing manufacturer.

2.03 EPDM MEMBRANE MATERIALS

- A. Roofing and Flashing Membrane: Black, cured synthetic single-ply membrane composed of ethylene propylene diene monomer (EPDM) with the following properties:
 - 1. Reinforcement: None; membrane complying with ASTM D4637/D4637M Type I.
 - 2. Thickness: 0.060 inch.
 - 3. Nominal Thickness Tolerance: Plus/minus 10 percent.
 - 4. Sheet Width: Provide the widest available sheets to minimize field seaming.
 - 5. Acceptable Product: RubberGard Non-Reinforced Low Slope Fire Retardant EPDM Membrane by Firestone.
- B. Membrane Fasteners: Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.
- C. Flashing Membrane: Self-curing, non-reinforced membrane composed of nonvulcanized EPDM rubber, complying with ASTM D4811/D4811M Type II, and with the following properties:
 - 1. Thickness: 0.055 inch.
 - 2. Acceptable Product: RubberGard EPDM FormFlash by Firestone.
- D. Self-Adhesive Flashing Membrane: Semi-cured 45 mil EPDM membrane laminated to 35 mil EPDM tape adhesive; QuickSeam Flashing by Firestone.
- E. Pre-Molded Pipe Flashings: EPDM, molded for quick adaptation to different sized pipes; Firestone EPDM Pipe Flashing.
- F. Self-Adhesive Lap Splice Tape: 35 mil EPDM-based, formulated for compatibility with EPDM membrane and high-solids primer; QuickSeam Splice Tape by Firestone.
- G. Splice Adhesive: Synthetic polymer-based, formulated for compatibility with EPDM membrane and metal surfaces; SA-1065 Splice Adhesive by Firestone.
- H. Bonding Adhesive: Neoprene-based, formulated for compatibility with EPDM membrane and wide variety of substrate materials, including masonry, wood, and insulation facings; Bonding Adhesive BA-2004 by Firestone.
- I. Adhesive Primer: Synthetic rubber based primer formulated for compatibility with EPDM membrane and tape adhesive; QuickPrime Plus by Firestone.
- J. Seam Edge Treatment: EPDM rubber-based sealant, formulated for sealing exposed edges of membrane at seams; Lap Sealant HS by Firestone.

- K. Pourable Sealer: Two-part polyurethane, two-color for reliable mixing; Pourable Sealer by Firestone.
- L. Water Block Seal: Butyl rubber sealant for use between two surfaces, not exposed; Water Block Seal by Firestone.
- M. Metal Plates and Strips Used for Fastening Membrane and Insulation: Steel with Galvalume coating; corrosion-resistance meeting FM 4470 criteria.
- N. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches wide by 0.10 inch thick; Firestone Termination Bar by Firestone.
- O. Roof Walkway Pads: EPDM, 0.30 inch thick by 30 by 30 inches with EPDM tape adhesive strips laminated to the bottom; QuickSeam Walkway Pads by Firestone.

2.04 VAPOR RETARDER MATERIALS

- A. Membrane: Self-Adhered SBS polymer-modified bitumen adhesive, factory-laminated to a tri-laminate woven, high-density polyethylene top surface; Firestone V-Force Vapor Barrier
- B. Primer: As recommended by roofing membrane manufacturer.

2.05 ROOF INSULATION AND COVER BOARDS

- A. Polyisocyanurate Board Insulation: Closed cell polyisocyanurate foam with black glass reinforced mat laminated to faces, complying with ASTM C1289 Type II Class 1, with the following additional characteristics:
 - 1. Thickness: As indicated elsewhere.
 - 2. Size: 48 inches by 96 inches, nominal.
 - 3. R-value (LTTR):
 - a. 2.6 inch Thickness: 15.0, minimum.
 - 4. Compressive Strength: 20 psi when tested in accordance with ASTM C1289.
 - 5. Ozone Depletion Potential: Zero; made without CFC or HCFC blowing agents.
 - 6. Recycled Content: 19 percent post-consumer and 15 percent pre-consumer (post-industrial), average.
 - 7. Acceptable Product: ISO 95+ GL Polyisocyanurate Insulation by Firestone.

2.06 ACCESSORY MATERIALS

- A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
 - 1. Width: 3-1/2 inches, nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
 - 2. Thickness: Same as thickness of roof insulation.
- B. Stone Ballast: Washed, round, smooth water worn gravel with rounded edges and corners, relatively free of fractures, loam, sand or other foreign substances.
 - 1. Size: Complying with ASTM D448 size #4 - 1-1/2 to 3/4 inch when tested in accordance with ASTM C136/C136M.

PART 3 INSTALLATION

3.01 GENERAL

- A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.
- B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.
- C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.
- D. Perform work using competent and properly equipped personnel.
- E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.
- F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F.
- G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
 - 1. Protect from spills and overspray from bitumen, adhesives, sealants and coatings.

2. Particularly protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within the range of wind-borne overspray.
 3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.
- H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.
- I. Consult membrane manufacturer's instructions, container labels, and Material Safety Data Sheets (MSDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.02 EXAMINATION

- A. Examine roof deck to determine that it is sufficiently rigid to support installers and their mechanical equipment and that deflection will not strain or rupture roof components or deform deck.
- B. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.
- C. Examine roof substrate to verify that it is properly sloped to drains.
- D. Verify that the specifications and drawing details are workable and not in conflict with the roofing manufacturer's recommendations and instructions; start of work constitutes acceptable of project conditions and requirements.
- E. Verify that wood nailers have been properly installed.

3.03 PREPARATION

- A. Take appropriate measures to ensure that fumes from adhesive solvents are not drawn into the building through air intakes.
- B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.
- C. Fill all surface voids in the immediate substrate that are greater than 1/4 inch wide with fill material acceptable insulation to membrane manufacturer.
- D. Seal, grout, or tape deck joints, where needed, to prevent bitumen seepage into building.

3.04 VAPOR RETARDER

- A. Before installing insulation install vapor retarder directly over the deck.

- B. Install self-adhered modified bitumen base sheet as required by manufacturer. Prime concrete deck with manufacturer's approved primer.
- C. Ensure that all penetrations and edge conditions are sealed to prevent moisture and air drive into the roofing system.

3.05 INSULATION INSTALLATION

- A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roofing System.
- B. Install insulation in a manner that will not compromise the vapor retarder integrity.
- C. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.
- D. Lay roof insulation in courses parallel to roof edges.
- E. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch. Fill gaps greater than 1/4 inch with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch.
- F. Loose Laid Installation: Install insulation by laying loose over substrate without mechanical securement of any kind.

3.06 SINGLE-PLY MEMBRANE INSTALLATION

- A. Beginning at low point of roof, place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.
- B. Lay out the membrane pieces so that field and flashing splices are installed to shed water.
- C. Install membrane without wrinkles and without gaps or fishmouths in seams; bond and test seams and laps in accordance with membrane manufacturer's instructions and details.
- D. Install membrane loose laid, with edge securement as specified.
- E. Edge Securement: Secure membrane at all locations where membrane terminates or goes through an angle change greater than 2 in 12 inches using mechanically fastened reinforced perimeter fastening strips, plates, or metal edging as indicated or as recommended by roofing manufacturer.
 - 1. Exceptions: Round pipe penetrations less than 18 inches in diameter and square penetrations less than 4 inches square.
 - 2. Metal edging is not merely decorative; ensure anchorage of membrane as intended by roofing manufacturer.

3.07 FLASHING AND ACCESSORIES INSTALLATION

- A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.
- B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
 - 1. Follow roofing manufacturer's instructions.
 - 2. Remove protective plastic surface film immediately before installation.
 - 3. Install water block sealant under the membrane anchorage leg.
 - 4. Flash with manufacturer's recommended flashing sheet unless otherwise indicated.
 - 5. Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.
 - 6. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.
 - 7. When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.
- C. Scuppers: Set in sealant and secure to structure; flash as recommended by manufacturer.
- D. Roofing Expansion Joints: Install as shown on drawings and as recommended by roofing manufacturer.
- E. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weathertight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches high above membrane surface.
 - 1. Use the longest practical flashing pieces.
 - 2. Evaluate the substrate and overlay and adjust installation procedure in accordance with membrane manufacturer's recommendations.
 - 3. Complete the splice between flashing and the main roof sheet with specified splice adhesive before adhering flashing to the vertical surface.
 - 4. Provide termination directly to the vertical substrate as shown on roof drawings.

F. Roof Drains:

1. Taper insulation around drain to provide smooth transition from roof surface to drain. Use specified pre-manufactured tapered insulation with facer or suitable bonding surface to achieve slope; slope not to exceed manufacturer's recommendations.
2. Position membrane, then cut a hole for roof drain to allow 1/2 to 3/4 inch of membrane to extend inside clamping ring past drain bolts.
3. Make round holes in membrane to align with clamping bolts; do not cut membrane back to bolt holes.
4. Apply sealant on top of drain bowl where clamping ring seats below the membrane
5. Install roof drain clamping ring and clamping bolts; tighten clamping bolts to achieve constant compression.

G. Flashing at Penetrations: Flash all penetrations passing through the membrane; make flashing seals directly to the penetration.

1. Pipes, Round Supports, and Similar Items: Flash with specified pre-molded pipe flashings wherever practical; otherwise use specified self-curing elastomeric flashing.
2. Pipe Clusters and Unusual Shaped Penetrations: Provide penetration pocket at least 2 inches deep, with at least 1 inch clearance from penetration, sloped to shed water.
3. Structural Steel Tubing: If corner radii are greater than 1/4 inch and longest side of tube does not exceed 12 inches, flash as for pipes; otherwise, provide a standard curb with flashing.
4. Flexible and Moving Penetrations: Provide weathertight gooseneck set in sealant and secured to deck, flashed as recommended by manufacturer.
5. High Temperature Surfaces: Where the in-service temperature is, or is expected to be, in excess of 180 degrees F, protect the elastomeric components from direct contact with the hot surfaces using an intermediate insulated sleeve as flashing substrate as recommended by membrane manufacturer.

3.08 FINISHING AND WALKWAY INSTALLATION

- A. Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.
1. Use specified walkway pads unless otherwise indicated.

- B. Walkway Pads: Adhere to the roofing membrane, spacing each pad at minimum of 1.0 inch and maximum of 3.0 inches from each other to allow for drainage.
 - 1. If installation of walkway pads over field fabricated splices or within 6 inches of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches on either side.
 - 2. Prime the membrane, remove the release paper on the pad, press in place, and walk on pad to ensure proper adhesion.
- C. Ballast: Install over completed membrane each work day.
 - 1. Do not stockpile ballast or paver materials on the roof.
 - 2. At areas where ballast is loaded, protect the membrane and underlying insulation using insulation or plywood over an additional layer of roofing membrane.
 - 3. Stone Ballast: Apply at rates specified in PART 2; soft rubber tired ballast buggies may be used; spread ballast around penetrations by hand.
 - 4. Ballast displaced by a non-paver walkway should be distributed around the pad, to maintain the specified average ballast rate.

3.09 FIELD QUALITY CONTROL

- A. See Section 01 4000 - Quality Requirements, for additional requirements.
- B. Inspection by Manufacturer: Provide final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes (i.e. not a sales person).
- C. Perform all corrections necessary for issuance of warranty.

3.10 CLEANING

- A. Clean all contaminants generated by roofing work from building and surrounding areas, including bitumen, adhesives, sealants, and coatings.
- B. Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.
- C. Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

3.11 PROTECTION

- A. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Manufactured reglets with counterflashing
 - 2. Formed low-slope roof sheet metal fabrications.
 - 3. Formed wall sheet metal fabrications.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For sheet metal flashing and trim.
 - 1. Include plans, elevations, sections, and attachment details.
 - 2. Distinguish between shop- and field-assembled work.
 - 3. Include identification of finish for each item.
 - 4. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.
- C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.05 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.

1. For copings and roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

1.06 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
 1. Finish Warranty Period: **10** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Sheet Metal Standard for Copper: Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- D. SPRI Wind Design Standard: Manufacture and install copings roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
 1. Design Pressure: [As indicated on Drawings] <Insert design pressure>.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.02 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet according to ASTM A 653/A 653M, G90 (Z275) coating designation or aluminum-zinc alloy-coated steel sheet according to ASTM A 792/A 792M, Class AZ50

(Class AZM150) coating designation, Grade 40 (Grade 275); prepainted by coil-coating process to comply with ASTM A 755/A 755M.

1. Surface: Manufacturer's standard clear acrylic coating on both sides.
2. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
3. Color: As selected by Architect from manufacturer's full range.

2.03 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt; nonperforated.
- B. Synthetic Underlayment: Laminated or reinforced, woven polyethylene or polypropylene, synthetic roofing underlayment; bitumen free; slip resistant; suitable for high temperatures over 220 deg F (111 deg C); and complying with physical requirements of ASTM D 226/D 226M for Type I and Type II felts.
- C. Self-Adhering, High-Temperature Sheet: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer according to written recommendations of underlayment manufacturer.
 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C) or higher.
 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C) or lower.
- D. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

2.04 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal or manufactured item unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal or manufactured item.
 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
 - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed

- EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
 - b. Blind Fasteners: High-strength aluminum or stainless-steel rivets suitable for metal being fastened.
 - c. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 2. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.
- C. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- F. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- G. Bituminous Coating: Cold-applied asphalt emulsion according to ASTM D 1187.
- H. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.05 MANUFACTURED REGLETS

- A. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
 - 1. Material: Galvanized steel, 0.022 inch (0.56 mm) thick.
 - 2. Finish: [Mill] [With manufacturer's standard color coating] <Insert finish>.

2.06 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
 - 1. Obtain field measurements for accurate fit before shop fabrication.

2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
 3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
- C. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.
- D. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- E. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard for application, but not less than thickness of metal being secured.
- F. Seams: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.

2.07 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners, fasten and seal watertight.
1. Fabricate from the Following Materials:
 - a. Aluminum-Zinc Alloy-Coated Steel: 0.040 inch (1.02 mm) thick.
- B. Base Flashing: Fabricate from the following materials:
1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
- C. Counterflashing and Flashing Receivers: Fabricate from the following materials:
1. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.
- D. Roof-Penetration Flashing: Fabricate from the following materials:
1. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
- E. Roof-Drain Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.016 inch (0.40 mm) thick.

PART 3 - EXECUTION

3.01 UNDERLAYMENT INSTALLATION

- A. Felt Underlayment: Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- B. Synthetic Underlayment: Install synthetic underlayment, wrinkle free, according to manufacturers' written instructions, and using adhesive where possible to minimize use of mechanical fasteners under sheet metal.
- C. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Prime substrate if recommended by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller. Cover underlayment within 14 days.

3.02 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
 - 2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
 - 4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
 - 5. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
 - 1. Coat concealed side of uncoated-aluminum and stainless-steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.

2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
 2. Use lapped expansion joints only where indicated on Drawings.
 - D. Fasteners: Use fastener sizes that penetrate [wood blocking or sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws] [substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance] <Insert size requirement>.
 - E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.
 - F. Seal joints as required for watertight construction. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
 - G. Rivets: Rivet joints in uncoated aluminum where necessary for strength.

3.03 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Copings: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated.
- C. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.
- D. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints minimum of 4 inches (100 mm).
- E. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.04 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

3.05 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:
 - a. Construction joints in cast-in-place concrete.
 - b. Control and expansion joints in unit masonry.
 - c. Joints between metal panels.
 - d. Joints between different materials listed above.
 - e. Perimeter joints between materials listed above and frames of doors windows and louvers.
 - f. Control and expansion joints in overhead surfaces.
 - g. Other joints as indicated.
 - 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Isolation and contraction joints in cast-in-place concrete slabs.
 - b. Joints between different materials listed above.
 - c. Other joints as indicated.
 - 3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control and expansion joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
 - d. Perimeter joints between interior wall surfaces and frames of interior doors and windows.
 - e. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - f. Other joints as indicated.
 - 4. Interior joints in the following horizontal traffic surfaces:
 - a. Isolation joints in cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated.

1.02 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.03 SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each type and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- E. Qualification Data: For Installer.
- F. Warranties: Special warranties specified in this Section.

1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of elastomeric sealants required for this Project.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
 - 1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

1.05 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.06 WARRANTY

- A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
 2. Disintegration of joint substrates from natural causes exceeding design specifications.
 3. Mechanical damage caused by individuals, tools, or other outside agents.
 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

2.02 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.03 ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- C. Single-Component Neutral-Curing Silicone Sealant ES-#1:
1. Available Products:
 - a. Dow Corning Corporation; 791.
 - b. Dow Corning Corporation; 795
 - c. GE Silicones; SilPruf NB SCS9000.
 - d. GE Silicones; UltraPruf II SCS2900.
 - e. Pecora Corporation; 865.
 - f. Pecora Corporation; 895.
 - g. Pecora Corporation; 898.
 2. Type and Grade: S (single component) and NS (nonsag).
 3. Class: 50.
 4. Use Related to Exposure: NT (nontraffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates O.
 6. Stain-Test-Response Characteristics: Nonstaining to porous substrates per ASTM C 1248.
- D. Single-Component Mildew-Resistant Neutral-Curing Silicone Sealant ES-#2:
1. Available Products:
 - a. Pecora Corporation; 898.
 - b. Tremco; Tremsil 600 White.
 2. Type and Grade: S (single component) and NS (nonsag).
 3. Class: 25.
 4. Use Related to Exposure: NT (nontraffic).

5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates O.
- E. Multicomponent Nonsag Urethane Sealant ES-#3:
1. Available Products:
 - a. Pecora Corporation; Dynatrol II.
 - b. Tremco; Dymeric 511.
 - c. Tremco; Vulkem 922.
 2. Type and Grade: M (multicomponent) and NS (nonsag).
 3. Class: 50.
 4. Uses Related to Exposure: NT (nontraffic) and T (traffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates, O.
- F. Multicomponent Pourable Urethane Sealant ES-#4:
1. Available Products:
 - a. Pecora Corporation; Dynatrol II-SG.
 - b. Sika Corporation, Inc.; Sikaflex - 2c SL.
 - c. Sonneborn, Division of ChemRex Inc.; SL 2.
 2. Type and Grade: M (multicomponent) and P (pourable).
 3. Class: 25.
 4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates O.
- G. Single-Component Nonsag Urethane Sealant ES-#5:
1. Available Products:
 - a. Sika Corporation, Inc.; Sikaflex - 1a.
 - b. Sonneborn, Division of ChemRex Inc.; Ultra.
 - c. Sonneborn, Division of ChemRex Inc.; NP 1.
 - d. Tremco; Vulkem 116.
 2. Type and Grade: S (single component) and NS (nonsag).
 3. Class: 25.
 4. Uses Related to Exposure: T (traffic) and NT (nontraffic).
 5. Uses Related to Joint Substrates: M, G, A, and, as applicable to joint substrates O.

2.04 LATEX JOINT SEALANTS

- A. Latex Sealant LS-#1: Comply with ASTM C 834, Type P, Grade NF.
- B. Available Products:

1. Bostik Findley; Chem-Calk 600.
2. Pecora Corporation; AC-20+.
3. Schnee-Morehead, Inc.; SM 8200.
4. Sonneborn, Division of ChemRex Inc.; Sonolac.
5. Tremco; Tremflex 834.

2.05 JOINT-SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.06 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air. Porous joint substrates include the following:
 - a. Concrete.
 - b. Masonry.
 - c. Unglazed surfaces of ceramic tile.
 - d. Stone.
 3. Remove laitance and form-release agents from concrete.
 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
 - a. Metal.
 - b. Glass.
 - c. Porcelain enamel.
 - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.03 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- E. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- F. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- G. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
 - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- H. Installation of Preformed Tapes: Install according to manufacturer's written instructions.

3.04 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.06 JOINT-SEALANT SCHEDULE

- A. Joint-Sealant Application JS-#1: Exterior vertical construction joints in cast-in-place and precast concrete.
 - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-#3.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- B. Joint-Sealant Application JS-#2: Exterior horizontal nontraffic and traffic isolation and contraction joints in cast-in-place concrete slabs.
 - 1. Joint Sealant: Multicomponent pourable urethane sealant ES-#4.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- C. Joint-Sealant Application JS-#3: Exterior vertical joints between different materials listed above.
 - 1. Joint Sealant: Single-component nonsag urethane sealant ES-#5.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- D. Joint-Sealant Application JS-#4: Exterior perimeter joints between concrete and frames of doors, windows and louvers.
 - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-#3.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- E. Joint-Sealant Application JS-#5: Vertical control and expansion joints on exposed interior surfaces of exterior walls.
 - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-#3.
 - 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- F. Joint-Sealant Application JS-#6: Interior perimeter joints of exterior openings.
 - 1. Joint Sealant: Multicomponent nonsag urethane sealant ES-#3.

2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- G. Joint-Sealant Application JS-#7: Interior ceramic tile expansion, control, contraction, and isolation joints in horizontal traffic surfaces.
1. Joint Sealant: Multicomponent pourable urethane sealant ES-#4.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- H. Joint-Sealant Application JS-#8: Interior joints between plumbing fixtures and adjoining walls, floors, and counters.
1. Joint Sealant: Single-component mildew-resistant neutral -curing silicone sealant ES-#2.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- I. Joint-Sealant Application JS-#9: Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
1. Joint Sealant: Multicomponent nonsag urethane sealant ES-#3.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
- J. Joint-Sealant Application JS-#10: Perimeter joints between interior wall surfaces and frames of interior doors and windows.
1. Joint Sealant: Latex sealant LS-#1.
 2. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION 07 92 00

DIVISION 08 OPENINGS

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Standard hollow metal doors. Standard hollow metal may be used at all locations where the requirements of the drawings and specifications permit.
 - 2. Custom hollow metal frames.

1.02 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings.
- B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.
- C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.03 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, and temperature-rise ratings where required by governing authorities, and finishes.
- B. Shop Drawings: Include the following:
 - Elevations of each door design.
 - 1. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - 2. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 3. Locations of reinforcement and preparations for hardware.
 - 4. Details of each different wall opening condition.
 - 5. Details of anchorages, joints, field splices, and connections.
 - 6. Details of accessories.
 - 7. Details of moldings, removable stops, and glazing.
 - 8. Details of conduit and preparations for power, signal, and control systems.
- C. Over size Construction Certification: For assemblies required to be fire rated and exceeding limitations of labeled assemblies.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.04 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
 - 2. Temperature-Rise Limit: Where required by governing authorities, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.
- C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9 Label each individual glazed lite.
- D. Smoke-Control Door Assemblies: Comply with NFPA 105 or UL 1784.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
 - 1. Provide additional protection to prevent damage to finish of factory-finished units.
 - 2. Inspect hollow metal work upon delivery for damage. Minor damages may be repaired provided the finished items are equal in all respects to new work and acceptable to the Architect. Otherwise, remove and replace damaged items as directed.
 - 3. If cardboard wrappers on doors become wet, remove immediately.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.06 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.07 COORDINATION

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Doors and Frames, (General):
 - a. Ceco Door Products; an Assa Abloy Group company.
 - b. Curries Company; an Assa Abloy Group company.
 - c. Fenestra Corp.
 - d. Steelcraft; an Ingersoll-Rand company.
 - e. Windsor Republic Doors, Inc.

2.02 MATERIALS

- A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled complying with ASTM A 569 and ASTM A 568.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526, with ASTM A 525, G60 zinc coating, mill phosphatized.
- D. Supports and Anchors: Fabricated of not less than 18-gauge galvanized sheet steel.
- E. Inserts, Bolts, and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built in to exterior walls, complying with ASTM A 153/, Class C or D as applicable.
- F. Shop Applied Paint:
 - 1. Primer: Rust-inhibitive enamel or paint, either air-drying or baking, suitable as base for specified finish paints.

- G. Glazing: Comply with requirements in Division 08 Section "Glazing."

2.03 STANDARD HOLLOW METAL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8.
1. Design: Flush panel
 2. Core Construction: Manufacturer's standard vertical steel-stiffener core.
 - a. Fire Door Core: As required to provide fire-protection ratings indicated. Provide temperature-rise rating as required by governing authorities.
 - b. Thermal-Rated (Insulated) Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 6.0 deg F x h x sq. ft./Btu when tested according to ASTM C 1363.
 - 1) Locations: Exterior doors.
 3. Vertical Edges for Single-Acting Doors: Beveled edge.
 - a. Beveled Edge: 1/8 inch in 2 inches.
 4. Vertical Edges for Double-Acting Doors: Round vertical edges with 2-1/8-inch radius.
 5. Top and Bottom Edges: Closed with flush or inverted 0.042-inch-thick, end closures or channels of same material as face sheets.
 6. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:
1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 1 (Full Flush) Model 2 (Seamless) or Model 3 (Stile and Rail) if Stile and Rail doors are indicated on drawings.
- C. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.04 STANDARD HOLLOW METAL FRAMES

- A. General: Provide Hollow Metal Frames for doors, transoms, sidelights, borrowed lights, and other openings as shown on drawings on schedules. Fabricate frames of construction indicated.
1. Close contact edges of corner joints tight with faces mitered and stops butted or mitered. Continuously weld faces and soffits and finish faces smooth. Comply with ANSI/NAAMM-HMMA 861.
 2. Fabricated from 16-gage cold-rolled steel.
 3. Form exterior frames of hot-dip galvanized steel.

- B. Exterior Frames: Formed from metallic-coated steel sheet.
- C. Hardware Reinforcement: Fabricate according to ANSI/NAAMM-HMMA 861 with reinforcing plates from same material as frame.
- D. Door Silencers: Except on weather-stripped frames, drill stops to receive 2 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.
- E. Plaster Guards: Provide 26-gauge steel plaster guards or mortar boxes, weld to frame at back of finish hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior openings.

2.05 FRAME ANCHORS

- A. Jamb Anchors:
 - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.05 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 - 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.05 inch thick.
 - 3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
 - 4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch thick, and as follows:
 - 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.06 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.07 ACCESSORIES

- A. Grout Guards: Formed from same material as frames, not less than 0.016 inch thick.

2.08 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Fabricate exposed faces of door and panels, including stiles and rails of non-flush units from only cold-rolled steel.
- C. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117 for Standard Hollow Metal or ANSI/NAAMM-HMMA 861 Custom Hollow Metal.
- D. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
 - 3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
- E. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 4. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Fire ratings may require additional anchors.
 - b. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.

- c. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
 - d. Compression Type: Not less than two anchors in each jamb.
 - e. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 - 6. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.
 - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- F. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- G. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 08 Section "Door Hardware."
 - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8 for Standard Hollow Metal or ANSI/NAAMM-HMMA 861 for Custom Hollow Metal.
 - 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 - 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 - 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 Sections.
- H. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 - 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - 4. Provide loose stops and moldings on inside of hollow metal work.
 - 5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.09 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.
 - 1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Verify with framing Contractor that 18 gauge minimum metal thickness studs were installed in wall framing adjacent to hollow metal frames per Cold-Formed Metal Framing and Non-Structural Metal Framing specifications.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 - 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.03 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 for Standard Hollow Metal or HMMA 840 Custom Hollow Metal.
 - 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - 4. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
 - 5. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
 - 6. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 7. Non-Fire-Rated Standard Steel Doors:

- a. Jams and Head: 1/8 inch plus or minus 1/16 inch.
- b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
- c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
- d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.

3.04 JUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- D. Metallic-Coated Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 08 11 13

SECTION 08 16 13

FIBERGLASS REINFORCED DOORS AND FRAMES

PART 1 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 this section.

1.02 SUMMARY

- A. This Section includes fiberglass reinforced plastic (FRP) doors and frames.
- B. Related Sections:
 - 1. Division 7 – Joint Sealers; Perimeter sealant and backup materials.
 - 2. Division 8 – Door Hardware.

1.03 REFERENCES

- A. ASTM D 523 - Standard Test Method for Specular Gloss.
- B. ASTM D 635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position.
- C. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- D. ASTM E 152 – Standard Methods of Fire Tests of Door Assemblies.
- E. NFPA 252 – Standard Methods of Fire Tests of Door Assemblies.
- F. SDI 100 – Recommended Specifications for Steel Doors and Frames.
- G. UL 10B- Standard for Fire Tests of Door Assemblies.
- H. UL 305 – Standard for Panic Hardware.

1.04 PERFORMANCE REQUIREMENTS

- A. Door opening assemblies:

1. Maximum flame spread 25 in accordance with ASTM E 84, self-extinguishing in accordance with ASTM D 635.
- B. Fire rated assemblies: Comply with requirements of UL10B, NFPA 252, and ASTM E 152; with doors and frames bearing rating labels.
- C. Fire rated assemblies: Comply with requirements of UL10B, NFPA 252, and ASTM E 152; UL ratings indicated on drawings, with doors and frames bearing rating labels.

1.05 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Submit Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Shop Drawings:
 1. Plans: Indicate location of each door opening assembly in project.
 2. Elevations: Dimensioned elevation of each type door opening assembly in project; indicate sizes and locations of door hardware, and lites and louvers, if specified.
 3. Details: Installation details of each type installation condition in project; indicate installation details of glazing, if specified.
 4. Schedule: Indicate each door opening assembly in project; cross-reference to plans, elevations, and details.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- F. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
- G. Closeout: Submit warranty documents specified herein.

1.06 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing fiberglass doors and frames with a minimum documented experience of ten years.
- B. Installer Qualifications: Company specializing in installation of fiberglass doors and frames with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in manufacturer's unopened, undamaged packaging, with manufacturer's labels intact.
- B. Inspect and report damage to doors at time of delivery.
- C. Store products in manufacturer's unopened packaging until ready for installation.
- D. Store door assemblies in on end, to prevent damage to face corners and edges.

1.08 WARRANTY

- A. A. Manufacturer's Warranty: Manufacturer's 15-year warranty against failure due to corrosion from specified environment.

PART 2 PRODUCTS

2.01 MANUFACTURERS

Acceptable Manufacturer: Fib-R-Dor, a Div. of Chase Doors, Inc.; 1721 East 5th Street, North Little Rock, AR 72114. Ph. Toll Free: (800) 342-7367, Fax: 501-758-9496. Web Site: www.fibrdor.com E-mail: fibrdor@fibrdor.com or equal.

2.02 MATERIALS

- A. Fiberglass Mat: Glass fiber chopped strand, minimum 2 ounces per square foot.
- B. Resins: Manufacturer's formulation for fabricating units to meet specified requirements.
- C. Anchors: Manufacturer's standard stainless steel expansion anchors for existing openings, and stainless steel masonry tee anchors for new construction.
- D. Fasteners: Stainless steel.

2.03 COMPONENTS

- A. Non-rated, Fiberglass Reinforced Plastic (FRP) Doors, FG:
 - 1. Thickness: 1-3/4 inches (45 mm).
 - 2. Thermal insulating Value: 'R' factor 11.
 - 3. Construction:
 - a. Core: End-grain balsa wood, resin-impregnated.
 - b. Door Plates: Molded in one continuous piece, resin reinforced with hand-laid glass fiber mat, nominal 1/8 inch (3 mm) thick, minimum 15 mil gel-coated surface.
 - c. Door Edges: Minimum 3 layers Fiberglass mat reinforced machine tooled resin rich FRP matrix, 3/8-inch thick.
 - 4. Sizes: Indicated on drawings.
 - 5. Finish: Smooth gloss surface, minimum value of 88 in accordance with ASTM D523.

- a. Color: As selected by Architect from manufacturer's standard.
- B. Non-rated Frames:
 - 1. Construction: One-piece FRP satin finish gelcoated to match door color. Minimum 1/4-inch wall thickness, jamb-to-head joints mitered and reinforced with FRP clips and stainless steel fasteners; conforming to SDI requirements for performance equivalent to 16 gauge steel frames.
 - 2. Frame profile: 5-3/4 inches (146 mm) deep, 2 inches (51 mm) wide face; double rabbeted with 5/8 inch (16 mm) high stop.
 - 3. Sizes: Indicated on drawings.
- C. Frame Anchors: Types recommended by manufacturer for project conditions.
- D. Door Hardware: Specified Section 08710.

2.04 FABRICATION

- A. Fiberglass Reinforced Plastic (FRP) Doors:
 - 1. Minimum glass fiber to resin ratio: 35 percent.
 - 2. Mortise for lockset, and recess for strike plate in lock stile.
 - 3. Embed steel reinforcement for hinges in fiberglass matrix; provide for hinge leaf recesses in hinge stile.
- B. RTM molded FRP, Stainless Steel or Steel Frames:
 - 1. Mortise for lock strike, and recess for strike plate in lock jamb.
 - 2. Reinforce for hinges and other indicated hardware.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify openings are ready to receive work and opening dimensions and clearances are as indicated on approved shop drawings. Do not begin installation until openings have been properly prepared.
- B. If opening preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Acclimate doors and frames to site conditions for a minimum of 24 hours before installation.
- B. Do not remove labels from fire-rated doors and frames.

3.03 INSTALLATION

- A. Install door opening assemblies in accordance with approved shop drawings, SDI 100, and manufacturer's printed installation instructions, using installation methods and materials specified in installation instructions.

- B. Use anchorage devices to securely fasten sliding door assembly to wall construction without distortion or imposed stresses.
- C. Coordinate installation of thermal insulation at shim spaces at frame perimeter.
- D. Installation of door hardware is specified in Section 08710.
- E. Install door hardware in accordance with manufacturer's printed instructions, using through-bolts to secure surface applied hardware.
- F. Site Tolerances: Maintain plumb and level tolerances specified in manufacturer's printed installation instructions.

3.04 ADJUSTING

- A. Adjust doors in accordance with door manufacturer's maintenance instructions to swing open and shut without binding, and to remain in place at any angle without being moved by gravitational influence.
- B. Adjust door hardware to operate correctly in accordance with hardware manufacturer's maintenance instructions.

3.05 CLEANING

- A. Clean surfaces of door opening assemblies and sight-exposed door hardware in accordance with manufacturer's maintenance instructions.
- B. Remove labels and visible markings.

3.06 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

3.07 SCHEDULE

- A. Schedules: Refer to Door Schedule indicated on drawings.

END OF SECTION

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SECTION 08 31 00
FLOOR ACCESS HATCHES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installation of the following equipment in accordance with the provisions of the Contract Documents:
 - 1. Interior and Exterior Floor Access Hatches
- B. Related Sections include:
 - 1. Section 01 33 00 - Submittal Procedures.
 - 2. Section 01 45 00 - Quality Control.
 - 3. Section 01 61 00 - Common Product Requirements .
 - 4. Section 01 77 00 - Closeout Procedures .
 - 5. Section 01 78 23 - Operation and Maintenance Data.
 - 6. Section 43 25 13 - Submersible Wet Pit Sewage Pumps.

1.02 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00, detailed specifications, drawings, certified test results, and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.
- B. Manufacturer's Instructions: Furnish under provisions of Section 01 33 00.
- C. Manufacturer's Field Service Reports: Furnish, under provisions of Section 01 75 00, reports covering start up, demonstration, and instructions.
- D. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 on all parts, devices, equipment, and other accessories furnished forming the complete operational system. Include a complete write-up of how the system is to operate and how to make adjustments.

1.03 SYSTEM DESCRIPTION

- A. Contractor shall provide hatches of size, material, rating, and all other properties as shown on the Drawings and in the hatch schedule included in this Section.

1.04 QUALITY ASSURANCE

- A. The equipment supplier must have at least five continuous years experience in the design, application, and manufacture of access hatches. All material and equipment shall be new and of the highest quality.

- B. Hatches and all other specified accessories and appurtenances shall be furnished by the access hatch manufacturer to ensure compatibility and integrity of the individual components and provide the specified warranty for all components.
- C. In order to assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these specifications that all access hatch assemblies and accessories called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.

1.05 DELIVERY STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Owner until required for installation. Materials shall be stored in accordance with manufacturer's instructions.
- B. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.

1.06 WARRANTY REQUIREMENTS

- A. The equipment manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of one (1) year under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty.

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. Access Hatches:
 - 1. Nystrom
 - 2. Bilco
 - 3. Halliday Products

2.02 H2O LOAD RATED ALUMINUM ACCESS HATCHES

- A. Hatches shall be designed to meet H2O wheel loading requirements. Hatches shall be cast integral with the top slabs. Prior to manufacture and shipment of hatches, the placement of the hatches must be coordinated between Engineer, hatch manufacturer/supplier, pump manufacturer/supplier, and precast supplier. Final approval of hatches by Engineer must be received prior to manufacture and shipment.

- B. Hatches shall have a ¼" thick, one piece, mill finish, extruded aluminum frame, incorporating a continuous concrete anchor.
- C. The inside frame shall have a door support ledge on two (2) sides.
- D. The frame and ledge shall be supported by a full bed of concrete. The frame shall be coated with bitumastic coal tar epoxy where in contact with concrete.
- E. The hatch door panels shall be ¼" aluminum diamond plate.
- F. Doors shall open to 90 degrees with T-316 stainless-steel hold open arms. Hold open arms shall have vinyl gripped handles.
- G. Doors shall include stainless-steel spring assist arms. Doors shall not require more than 30 pounds of lifting force to open. Doors shall close flush with the frame and shall lock positively when shut.
- H. Hinges and all fastening hardware shall be T-316 stainless-steel.
- I. Provide flush T-316 stainless-steel spring-loaded slam lock operable with a stainless-steel removable key from the top. Provide a stainless-steel turn handle with vinyl grip for operating lock from the bottom.
- J. Provide flush lifting handle and recessed padlock hasp covered by a hinged lid flush with the surface.
- K. Hatches shall be single leaf for 36" square and smaller and double leaf for hatches larger than 36" square.
- L. Hatches shall include debris gasket and 1-1/2" drain coupling located in channel frame
- M. All hatches shall include a "Safe Hatch" option designed to cover the hole per OSHA Standard 1910.23, provide fall through protection and controlled confined space entry. The safety grate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and a minimum yield strength of 35,000 psi per ASTM B221. Grate design shall use safety factors as defined in the "Specification for Aluminum Structures" by the Aluminum Association, Inc., 5th Edition, December 1986 for "Bridge Type Structures. The aluminum safety grating shall be designed for a minimum live load of 300 psf with a maximum deflection of 1/150th of the span. Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum. Grate shall be painted with OSHA approved safety orange epoxy paint.

2.03 300 PSF LOAD RATED HATCHES

- A. Hatches shall be designed to meet H20 wheel loading requirements. Hatches shall be cast integral with the top slabs. Prior to manufacture and shipment of

hatches, the placement of the hatches must be coordinated between Engineer, hatch manufacturer/supplier, pump manufacturer/supplier, and precast supplier. Final approval of hatches by Engineer must be received prior to manufacture and shipment.

- B. Hatches shall have a ¼" thick, one piece, mill finish, extruded aluminum frame, incorporating a continuous concrete anchor.
- C. The inside frame shall have a door support ledge on two (2) sides.
- D. The frame and ledge shall be supported by a full bed of concrete. The frame shall be coated with bitumastic coal tar epoxy where in contact with concrete.
- E. The hatch door panels shall be ¼" aluminum diamond plate.
- F. Doors shall open to 90 degrees with T-316 stainless-steel hold open arms. Hold open arms shall have vinyl gripped handles.
- G. Doors shall include stainless-steel spring assist arms. Doors shall not require more than 30 pounds of lifting force to open. Doors shall close flush with the frame and shall lock positively when shut.
- H. Hinges and all fastening hardware shall be T-316 stainless-steel.
- I. Provide flush T-316 stainless-steel spring-loaded slam lock operable with a stainless-steel removable key from the top. Provide a stainless-steel turn handle with vinyl grip for operating lock from the bottom.
- J. Provide flush lifting handle and recessed padlock hasp covered by a hinged lid flush with the surface.
- K. Hatches shall be single leaf for 36" square and smaller and double leaf for hatches larger than 36" square.
- L. Hatches shall include debris gasket and 1-1/2" drain coupling located in channel frame
- M. All hatches shall include a "Safe Hatch" option designed to cover the hole per OSHA Standard 1910.23, provide fall through protection and controlled confined space entry. The safety grate shall be made of 6061-T6 aluminum with a minimum ultimate strength of 38,000 psi and a minimum yield strength of 35,000 psi per ASTM B221. Grate design shall use safety factors as defined in the "Specification for Aluminum Structures" by the Aluminum Association, Inc., 5th Edition, December 1986 for "Bridge Type Structures. The aluminum safety grating shall be designed for a minimum live load of 300 psf with a maximum deflection of 1/150th of the span. Welding shall be in accordance with ANSI/AWS D1.2-90 Structural Welding Code for Aluminum. Grate shall be painted with OSHA approved safety orange epoxy paint.

2.04 SCHEDULE

A. H-20 Load Rated Hatches

1. Backwash Lift Station Wetwell
 - a. Quantity: One (1)
 - b. Minimum Dimensions: 36" by 60", coordinate with Section 43 25 13 Supplier.
2. Decant Lift Station Wetwell
 - a. Quantity: One (1)
 - b. Minimum Dimensions: 48" by 60", coordinate with Section 43 25 13 Supplier.
3. Decant Lift Station Valve Vault
 - a. Quantity: One (1) Minimum Dimensions: 48" by 60", coordinate with Section 43 25 13 Supplier.

B. 300 PSF Rated Hatches

1. SBR2 Roof Access Hatches
 - a. Quantity: 2
 - b. Dimensions: 36" by 36", coordinate orientation with Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations.
- B. Systems to be installed complete with all necessary connections and accessories.
- C. Adjust hatches to operate in a proper manner and easily without binding.

3.02 SPARE PARTS

- A. Furnish the following spare parts:
 1. One (1) operating wrench per hatch

END OF SECTION 08 31 00

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SECTION 08 33 23

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Insulated service doors.
 - 2. Door curtain
 - 3. Hood
- B. Operation of coiling doors includes the following:
 - 1. Manual operation for PTB 100B.
- C. Provide complete operating door assemblies including door curtains, guides, hardware, and installation accessories.
- D. Related Requirements:
 - 1. Section 055000 "Metal Fabrications" for miscellaneous steel supports, door-opening framing, corner guards, and bollards.

1.02 ACTION SUBMITTALS

- A. Product Data: For each type and size of overhead coiling door and accessory.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.
 - 1. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
 - 2. Show locations of controls, locking devices detectors or replaceable fusible links, and other accessories.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.

1.03 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

1.04 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years' experience.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project with a minimum of three years' experience.
- C. Provide each rolling service door as a complete unit produced by one manufacturer, including frames, sections, brackets, guides, tracks, counterbalance mechanisms, hardware, operators and installation accessories to suit openings and head room allowable.
- D. Wind loading: Design and reinforce rolling service doors to withstand a 20 lb. per sq ft wind loading pressure.

1.06 DELIVERY, STORAGE, AND HANDLING:

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weather tight location.

1.07 PROJECT CONDITIONS:

- A. Maintain environmental conditions within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 COORDINATION:

- A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1.09 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of doors that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Basis-of-Design Product: Subject to compliance with requirements, of the Stormtite AP Model 627 by the Overhead Door Corp or equal.

2.02 OVERHEAD COILING INSULATED DOOR:

- A. Rolling door shall include insulated slate sections, guides, and hood
 1. Interlocking roll-formed flat profile slats fabricated of 24 gauge galvanized steel, insulated with rigid polyurethane for a total R of 10.9.
 2. Guides consist of galvanized angles.
 3. Hood to be fabricated of 24-gauge, minimum, galvanized steel with stiffening beads.
 4. Weather Seals: Include a hood baffle and side guides and bottom bar weather-stripping. Also provide a lintel brush.
 5. Vision Panels: As shown on the Drawings.
 6. Finish shall be powder coated, Powder Guard applied to entire door system including slats, guides, bottom bar and head plate. Color shall be selected by Architect from manufacturer's standard colors.

2.03 COUNTERBALANCING MECHANISMS

- A. Counterbalance: Helical torsion spring type designed for standard 20,000 cycle life design. Counter balance shall be housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03" per foot of span. Counterbalance shall be adjustable by means of an adjusting tension wheel.
 1. Springs: furnished with oil tempered helical torsion springs having 25% overload factor for optimum ease of operation. Springs shall be fixed to a tapered cast anchors, mounted on a single steel torsion rod.
 2. Spring Tension: adjustable without removing the hood.
 3. Ball Bearing: high performance sealed ball bearing to alleviate wear of pipe shaft rotation around inner shaft.

2.04 MANUAL DOOR OPERATORS (PTB 100B ONLY)

- A. General: Equip door with manual door operator by door manufacturer.
- B. Chain-Hoist Operator: Consisting of endless steel hand chain, chain-pocket wheel and guard, and gear-reduction unit with a maximum 30-lbf (133-N) force for door operation. Provide alloy-steel hand chain with chain holder secured to operator guide.
- C. Locking Device: Equip door with slide bolt for padlock on interior side of door.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify opening sizes, tolerances and conditions are acceptable. Examine conditions of substrates, supports, and other conditions under which this work is to be performed. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

- A. Clean surfaces thoroughly prior to installation. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports according to final shop drawings, manufacturer's instructions, and as specified.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended for structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical services with Division 26. Complete wiring from disconnect to unit components.
- F. Coordinate installation of sealants and backing materials at frame perimeter as specified in section 07 92 00.
- G. Instruct owner's personnel in proper operating procedures and maintenance schedule.

3.04 ADJUSTING

- A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.05 CLEANING

- A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.
- B. Remove labels and visible markings.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

3.06 PROTECTION

- A. Protect installed products until completion of project.

3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling doors.

END OF SECTION

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SECTION 08 71 00

DOOR HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

- A. Section includes:
 - 1. Mechanical door hardware for:
 - a. Swinging doors.
 - 2. The intent of the hardware specification is to specify the hardware for interior and exterior doors, and to establish a type, continuity, and standard of quality. However, it is the door hardware supplier's responsibility to thoroughly review existing conditions, schedules, specifications, drawings, and other Contract Documents to verify the suitability of the hardware specified.
- B. Exclusions: Unless specifically listed in hardware sets, hardware is not specified in this section for:
 - 1. Windows
 - 2. Cabinets (casework), including locks in cabinets
 - 3. Signage
 - 4. Toilet accessories
 - 5. Overhead doors
- C. Related Sections:
 - 1. Division 01 Section "Alternates" for alternates affecting this section.
 - 2. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.

1.03 REFERENCES

- A. UL - Underwriters Laboratories
 - 1. UL 305 - Panic Hardware

- B. DHI - Door and Hardware Institute
 - 1. Sequence and Format for the Hardware Schedule
 - 2. Recommended Locations for Builders Hardware
 - 3. Key Systems and Nomenclature
- C. ANSI - American National Standards Institute
 - 1. ANSI/BHMA A156.1 - A156.29, and ANSI/BHMA A156.31 - Standards for Hardware and Specialties

1.04 SUBMITTALS

- A. General:
 - 1. Submit in accordance with Conditions of Contract and Division 01 requirements.
 - 2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
 - 3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.
- B. Action Submittals:
 - 1. Product Data: Technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
 - 2. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
 - a. Door Index; include door number, heading number, and Architects hardware set number.
 - b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
 - c. Quantity, type, style, function, size, and finish of each hardware item.
 - d. Name and manufacturer of each item.
 - e. Fastenings and other pertinent information.
 - f. Location of each hardware set cross-referenced to indications on Drawings.
 - g. Explanation of all abbreviations, symbols, and codes contained in schedule.
 - h. Mounting locations for hardware.
 - i. Door and frame sizes and materials.
 - j. Name and phone number for local manufacturer's representative for each product.

3. Key Schedule:

- a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
- b. Use ANSI/BHMA A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
- c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
- d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
- e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
 - 1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
- f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.

4. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory or shop prepared for door hardware installation.

C. Informational Submittals:

1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.
2. Product data for electrified door hardware:
 - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
3. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

1. Operations and Maintenance Data: Provide in accordance with Division 01 and include:
 - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
 - b. Catalog pages for each product.
 - c. Factory order acknowledgement numbers (for warranty and service)
 - d. Name, address, and phone number of local representative for each manufacturer.
 - e. Parts list for each product.

- f. Final approved hardware schedule, edited to reflect conditions as-installed.
- g. Final keying schedule
- h. Copies of floor plans with keying nomenclature
- i. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.05 QUALITY ASSURANCE

- A. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.
 - 1. Warehousing Facilities: In Project's vicinity.
 - 2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
 - 3. Coordination Responsibility: Assist in coordinating installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
 - a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
- B. Architectural Hardware Consultant Qualifications: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
 - 1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC).
 - 2. Can provide installation and technical data to Architect and other related subcontractors.
 - 3. Can inspect and verify components are in working order upon completion of installation.
 - 4. Capable of producing wiring diagrams.
 - 5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.
- C. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
- D. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.
- E. Keying Conference

1. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including:
 - a. Function of building, flow of traffic, purpose of each area, degree of security required, and plans for future expansion.
 - b. Preliminary key system schematic diagram.
 - c. Requirements for key control system.
 - d. Requirements for access control.
 - e. Address for delivery of keys.

F. Pre-installation Conference

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Inspect and discuss preparatory work performed by other trades.
3. Inspect and discuss electrical roughing-in for electrified door hardware.
4. Review sequence of operation for each type of electrified door hardware.
5. Review required testing, inspecting, and certifying procedures.
6. Conference can be done remotely via web or conference call.

G. Coordination Conferences:

1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
 1. Deliver each article of hardware in manufacturer's original packaging.
- C. Project Conditions:
 1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
 2. Provide secure lock-up for door hardware delivered to Project. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- D. Protection and Damage:
 1. Promptly replace products damaged during shipping.
 2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.

3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- E. Deliver keys and permanent cores to Owner by registered mail or overnight package service.

1.07 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory or shop prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.08 WARRANTY

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 1. Warranty Period: Beginning from date of Substantial Completion, for durations indicated.
 - a. Closers:
 - 1) Mechanical: 10 years.
 - b. Exit Devices:
 - 1) Mechanical: 10 years.
 - c. Locksets:
 - 1) Mechanical: 10 years.
 2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approval of manufacturers and/or products other than those listed as "Scheduled Manufacturer" or "Acceptable Manufacturers" in the individual article for the product category shall be in accordance with QUALITY ASSURANCE article, herein.

- B. Approval of products from manufacturers indicated in “Acceptable Manufacturers” is contingent upon those products providing all functions and features and meeting all requirements of scheduled manufacturer’s product.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect’s approval.

2.02 MATERIALS

A. Fasteners

- 1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
- 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
- 3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
- 4. Install hardware with fasteners provided by hardware manufacturer.

B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.

- 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

2.03 HINGES

A. Manufacturers and Products:

- 1. Scheduled Manufacturer and Product: Ives 5BB series.
- 2. Acceptable Manufacturers and Products: Hager BB series, McKinney TB/T4B series, Stanley FBB Series.

B. Requirements:

- 1. Provide hinges conforming to ANSI/BHMA A156.1.
- 2. 1-3/4 inch (44 mm) thick doors, up to and including 36 inches (914 mm) wide:
 - a. Exterior: Standard weight, bronze or stainless steel, 4-1/2 inches (114 mm) high
 - b. Interior: Standard weight, steel, 4-1/2 inches (114 mm) high

3. 1-3/4 inch (44 mm) thick doors over 36 inches (914 mm) wide:
 - a. Exterior: Heavy weight, bronze/stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
4. 2 inches or thicker doors:
 - a. Exterior: Heavy weight, bronze or stainless steel, 5 inches (127 mm) high
 - b. Interior: Heavy weight, steel, 5 inches (127 mm) high
5. Provide three hinges per door leaf for doors 90 inches (2286 mm) or less in height, and one additional hinge for each 30 inches (762 mm) of additional door height.
6. Where new hinges are specified for existing doors or existing frames, provide new hinges of identical size to hinge preparation present in existing door or existing frame.
7. Hinge Pins: Except as otherwise indicated, provide hinge pins as follows:
 - a. Steel Hinges: Steel pins
 - b. Non-Ferrous Hinges: Stainless steel pins
 - c. Out-Swinging Exterior Doors: Non-removable pins
 - d. Out-Swinging Interior Lockable Doors: Non-removable pins
 - e. Interior Non-lockable Doors: Non-rising pins
8. Width of hinges: 4-1/2 inches (114 mm) at 1-3/4 inch (44 mm) thick doors, and 5 inches (127 mm) at 2 inches (51 mm) or thicker doors. Adjust hinge width as required for door, frame, and wall conditions to allow proper degree of opening.
9. All hinges to be ball bearing.

2.04 CONTINUOUS HINGES

A. Aluminum Geared

1. Manufacturers:
 - a. Scheduled Manufacturer: Ives.
 - b. Acceptable Manufacturers: Select, Stanley.
2. Requirements:
 - a. Provide aluminum geared continuous hinges conforming to ANSI/BHMA A156.26, Grade 1.
 - b. Provide aluminum geared continuous hinges, where specified in the hardware sets, fabricated from 6063-T6 aluminum.
 - c. Provide split nylon bearings at each hinge knuckle for quiet, smooth, self-lubricating operation.
 - d. Provide hinges capable of supporting door weights up to 450 pounds, and successfully tested for 1,500,000 cycles.

- e. On fire-rated doors, provide aluminum geared continuous hinges that are classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
- f. Provide aluminum geared continuous hinges with electrified option scheduled in the hardware sets. Provide with sufficient number and wire gage to accommodate electric function of specified hardware.
- g. Install hinges with fasteners supplied by manufacturer.
- h. Provide hinges 1 inch (25 mm) shorter in length than nominal height of door, unless otherwise noted or door details require shorter length and with symmetrical hole pattern.

2.05 FLUSH BOLTS

A. Manufacturers:

- 1. Scheduled Manufacturer: Door Controls.
- 2. Acceptable Manufacturers: Ives, Rockwood.

B. Requirements:

- 1. Provide automatic, constant latching, and manual flush bolts with forged bronze or stainless-steel face plates, extruded brass levers, and with wrought brass guides and strikes. Provide 12 inch (305 mm) steel or brass rods at doors up to 90 inches (2286 mm) in height. For doors over 90 inches (2286 mm) in height increase top rods by 6 inches (152 mm) for each additional 6 inches (152 mm) of door height. Provide dust-proof strikes at each bottom flush bolt.

2.06 COORDINATORS

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives.
- 2. Acceptable Manufacturers: Burns, Rockwood.

B. Requirements:

- 1. Where pairs of doors are equipped with automatic flush bolts, an astragal, or other hardware that requires synchronized closing of the doors, provide bar-type coordinating device, surface applied to underside of stop at frame head.
- 2. Provide filler bar of correct length for unit to span entire width of opening, and appropriate brackets for parallel arm door closers, surface vertical rod exit device strikes or other stop mounted hardware. Factory-prepared coordinators for vertical rod devices as specified.

2.07 CYLINDRICAL LOCKS – GRADE 1

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Falcon T series.
2. Acceptable Manufacturers and Products: Marks 195 Series, Corbin-Russwin CL3300 series, Sargent 10-Line.

B. Requirements:

1. Provide cylindrical locks conforming to ANSI/BHMA A156.2 Series 4000, Grade 1, and UL Listed for 3 hour fire doors.
2. Cylinders: Refer to “KEYING” article, herein.
3. Provide locks with standard 2-3/4 inches (70 mm) backset, unless noted otherwise, with 1/2 inch latch throw. Provide proper latch throw for UL listing at pairs.
4. Provide locksets with separate anti-rotation thru-bolts, and no exposed screws.
5. Provide independently operating levers with two external return spring cassettes mounted under roses to prevent lever sag.
6. Provide standard ASA strikes unless extended lip strikes are necessary to protect trim.
7. Provide electrified options as scheduled in the hardware sets.
8. Lever Trim: Solid cast levers without plastic inserts and wrought roses on both sides.
 - a. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.

2.08 EXIT DEVICES

A. Manufacturers and Products:

1. Scheduled Manufacturer and Product: Falcon 24/25 series.
2. Acceptable Manufacturers and Products: Sargent 19-43-GL-80 series, Precision Apex series.

B. Requirements:

1. Provide exit devices tested to ANSI/BHMA A156.3 Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.
2. Cylinders: Refer to “KEYING” article, herein.
3. Provide touchpad type exit devices, fabricated of brass, bronze, stainless steel, or aluminum, plated to standard architectural finishes to match balance of door hardware.
4. Touchpad must extend a minimum of one half of door width. No plastic inserts are allowed in touchpads.
5. Provide exit devices with deadlatching feature for security and for future addition of alarm kits and/or other electrified requirements.
6. Provide flush end caps for exit devices.

7. Provide exit devices with manufacturer's approved strikes.
8. Provide exit devices cut to door width and height. Install exit devices at height recommended by exit device manufacturer, allowable by governing building codes, and approved by Architect.
9. Mount mechanism case flush on face of doors, or provide spacers to fill gaps behind devices. Where glass trim or molding projects off face of door, provide glass bead kits.
10. Provide cylinder or hex-key dogging as specified at non fire-rated openings.
11. Removable Mullions: 2 inches (51 mm) x 3 inches (76 mm) steel tube. Where scheduled as keyed removable mullion, provide type that can be removed by use of a keyed cylinder, which is self-locking when re-installed.
12. Provide exit devices with optional trim designs to match other lever and pull designs used on the project.
 - a. Tactile Warning (Knurling): Where required by authority having jurisdiction. Provide on levers on exterior (secure side) of doors serving rooms considered to be hazardous.

2.09 CYLINDERS

A. Manufacturers and Products:

1. Scheduled Manufacturer: Falcon.
2. Acceptable Manufacturers and Products: Best, Corbin-Russwin, Sargent, Yale.

B. Requirements:

1. Provide cylinders/cores, compliant with ANSI/BHMA A156.5; latest revision; cylinder face finished to match lockset, manufacturer's series as indicated. Refer to "KEYING" article, herein.
2. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.
 - a. Conventional Open: cylinder with small format interchangeable core (SFIC) core with open keyway

C. Construction Keying:

1. Replaceable Construction Cores.
 - a. Provide temporary construction cores replaceable by permanent cores, furnished in accordance with the following requirements.
 - 1) 3 construction control keys
 - 2) 12 construction change (day) keys.
 - b. Owner or Owner's Representative will replace temporary construction cores with permanent cores.

2.10 KEYING

- A. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- B. Comply with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.
- C. Requirements:
 - 1. Provide permanent cylinders/cores keyed by the manufacturer according to the following key system.
 - a. Master Keying system as directed by the Owner.
 - 2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements will be cause for replacement of cylinders/cores involved at no additional cost to Owner.
 - 3. Provide keys with the following features:
 - a. Material: Nickel silver; minimum thickness of .107-inch (2.3mm)
 - 4. Identification:
 - a. Mark permanent cylinders/cores and keys with applicable blind code per DHI publication "Keying Systems and Nomenclature" for identification. Do not provide blind code marks with actual key cuts.
 - b. Identification stamping provisions must be approved by the Architect and Owner.
 - c. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.
 - d. Failure to comply with stamping requirements will be cause for replacement of keys involved at no additional cost to Owner.
 - e. Forward permanent cylinders/cores to Owner, separately from keys, by means as directed by Owner.
 - 5. Quantity: Furnish in the following quantities.
 - a. Change (Day) Keys: 3 per cylinder/core.
 - b. Permanent Control Keys: 3.
 - c. Master Keys: 6.

2.11 DOOR CLOSERS

- A. Manufacturers and Products:
 - 1. Scheduled Manufacturer and Product: Falcon SC70A series.

2. Acceptable Manufacturers and Products: LCN 4050 series, Norton 7500 series, Sargent 351 series.

B. Requirements:

1. Provide door closers conforming to ANSI/BHMA A156.4 Grade 1 requirements by BHMA certified independent testing laboratory. ISO 9000 certify closers. Stamp units with date of manufacture code.
2. Provide door closers with fully hydraulic, full rack and pinion action with aluminum cylinder.
3. Closer Body: 1-1/2 inch (38 mm) diameter with 5/8 inch (16 mm) diameter heat-treated pinion journal.
4. Hydraulic Fluid: Fireproof, passing requirements of UL10C, and requiring no seasonal closer adjustment for temperatures ranging from 120 degrees F to -30 degrees F.
5. Spring Power: Continuously adjustable over full range of closer sizes, and providing reduced opening force as required by accessibility codes and standards.
6. Hydraulic Regulation: By tamper-proof, non-critical valves, with separate adjustment for latch speed, general speed, and backcheck.
7. Pressure Relief Valve (PRV) Technology: Not permitted.
8. Provide special templates, drop plates, mounting brackets, or adapters for arms as required for details, overhead stops, and other door hardware items interfering with closer mounting.

2.12 PROTECTION PLATES

A. Manufacturers:

1. Scheduled Manufacturer: Ives.
2. Acceptable Manufacturers: Burns, Rockwood.

B. Requirements:

1. Provide kick plates minimum of 0.050 inch (1 mm) thick, beveled four edges as scheduled. Furnish with sheet metal or wood screws, finished to match plates.
2. Sizes of plates:
 - a. Kick Plates: 10 inches (254 mm) high by 2 inches (51 mm) less width of door on single doors, 1 inch (25 mm) less width of door on pairs

2.13 OVERHEAD STOPS

A. Manufacturers:

1. Scheduled Manufacturers: Glynn-Johnson.
2. Acceptable Manufacturers: Rixson, Sargent.

B. Requirements:

1. Provide heavy duty concealed mounted overhead stop or holder as specified for exterior and interior vestibule single acting doors.
2. Provide heavy duty concealed mounted overhead stop or holder as specified for double acting doors.
3. Provide heavy or medium duty and concealed or surface mounted overhead stop or holder for interior doors as specified. Provide medium duty surface mounted overhead stop for interior doors and at any door that swings more than 140 degrees before striking wall, open against equipment, casework, sidelights, and where conditions do not allow wall stop or floor stop presents tripping hazard.
4. Where overhead holders are specified provide friction type at doors without closer and positive type at doors with closer.

2.14 DOOR STOPS

A. Manufacturers:

1. Scheduled Manufacturer: Ives.
2. Acceptable Manufacturers: Burns, Rockwood.

B. Provide door stops at each door leaf:

1. Provide wall stops wherever possible. Provide convex type where mortise type locks are used and concave type where cylindrical type locks are used.
2. Where a wall stop cannot be used, provide universal floor stops for low or high rise options.
3. Where wall or floor stop cannot be used, provide medium duty surface mounted overhead stop.

2.15 THRESHOLDS, SEALS, DOOR SWEEPS, AND GASKETING

A. Manufacturers:

1. Scheduled Manufacturer: Zero International.
2. Acceptable Manufacturers: National Guard, Reese.

B. Requirements:

1. Provide thresholds, weather-stripping (including door sweeps, seals, and astragals) and gasketing systems (including smoke, sound, and light) as specified and per architectural details. Match finish of other items.
2. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that meets requirements of assemblies tested according to UL 1784 and installed in compliance with NFPA 105.
3. Size of thresholds:

- a. Saddle Thresholds: 1/2 inch (13 mm) high by jamb width by door width
 - b. Bumper Seal Thresholds: 1/2 inch (13 mm) high by 5 inches (127 mm) wide by door width
- 4. Provide door sweeps, seals, astragals, and auto door bottoms only of type where resilient or flexible seal strip is easily replaceable and readily available.

2.16 SILENCERS

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives.
- 2. Acceptable Manufacturers: Burns, Rockwood.

B. Requirements:

- 1. Provide "push-in" type silencers for hollow metal or wood frames.
- 2. Provide one silencer per 30 inches (762 mm) of height on each single frame, and two for each pair frame.
- 3. Omit where gasketing is specified.

2.17 LATCH PROTECTORS

A. Manufacturers:

- 1. Scheduled Manufacturer: Ives.
- 2. Acceptable Manufacturers: Burns, Rockwood.

B. Provide stainless steel latch protectors of type required to function with specified lock.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: ANSI/SDI A250.8.
 - 2. Custom Steel Doors and Frames: HMMA 831.
 - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
 - 1. Replace construction cores with permanent cores as indicated in keying section.
- I. Key Control System: Tag keys and place them on markers and hooks in key control system cabinet, as determined by final keying schedule.
- J. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Mount closers so they are not visible in corridors, lobbies and other public spaces unless approved by Architect.
- K. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- L. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."

- M. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- N. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
- O. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
- P. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.03 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
 - 1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.
- B. Occupancy Adjustment: Approximately three to six months after date of Substantial Completion, Installer's Architectural Hardware Consultant must examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors and door hardware.

3.04 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

3.05 DOOR HARDWARE SCHEDULE

- A. Hardware items are referenced in the following hardware. Refer to the above-specifications for special features, options, cylinders/keying, and other requirements.
- B. Hardware Sets:

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HARDWARE GROUP NO. 01

For use on Door #(s):

PTB-102 EB-100A EB-100B

Provide each door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	SET	EXTERIOR HINGE	5BB1 SERIES (QTY, WEIGHT, SIZE, NRP AS REQ'D)	630	IVE
1	EA	PANIC HARDWARE	25-R-NL SNB	626	FAL
1	EA	MORTISE CYLINDER	C987	626	FAL
1	EA	SFIC CORE	C607	626	FAL
1	EA	SURFACE CLOSER (W/ SPRING STOP)	SC71A SS TBWMS	689	FAL
1	EA	KICK PLATE	8400 10" B-CS	630	IVE
1	EA	GASKETING	188S-BK @ HEAD & JAMBS	S-BK	ZER
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	568A-MSLA-10 - OR AS REQ'D BY SILL DETAIL	A	ZER

HARDWARE GROUP NO. 02

For use on Door #(s):

PTB-103

Provide each door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	SET	EXTERIOR HINGE	5BB1 SERIES (QTY, WEIGHT, SIZE, NRP AS REQ'D)	630	IVE
1	EA	STOREROOM LOCK	T581HD7 DANE	626	FAL
1	EA	SFIC CORE	C607	626	FAL
1	EA	LOCK GUARD	LG12 (PAINT TO MATCH DOOR/ FAME)	600	IVE
1	EA	SURFACE CLOSER (W/ SPRING STOP)	SC71A SS TBWMS	689	FAL
1	EA	KICK PLATE	8400 10" B-CS	630	IVE
1	EA	GASKETING	188S-BK @ HEAD & JAMBS	S-BK	ZER
1	EA	RAIN DRIP	142AA	AA	ZER
1	EA	DOOR SWEEP	39A	A	ZER
1	EA	THRESHOLD	568A-MSLA-10 - OR AS REQ'D BY SILL DETAIL	A	ZER

HARDWARE GROUP NO. FG-01

For use on Door #(s):

PTB-100A PTB-101A PTB-101B SBR-100A SBR-100B

Provide each door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	CONTINUOUS HINGE	112HD (OR AS REQ'D BY FRP DOOR MFG)	628	IVE
1	EA	STOREROOM LOCK	T581HD7 DANE	626	FAL
1	EA	SFIC CORE	C607	626	FAL
1	EA	LOCK GUARD	LG12 (PAINT TO MATCH DOOR/ FAME)	600	IVE
1	EA	SURFACE CLOSER (W/ SPRING STOP)	SC71A SS TBWMS	689	FAL
1	EA	RAIN DRIP	142AA	AA	ZER
1	SET	SEALS	PROVIDED BY DOOR/FRAME MFG		
1	EA	DOOR SWEEP	PROVIDED BY DOOR/FRAME MFG		
1	EA	THRESHOLD	568A-MSLA-10 - OR AS REQ'D BY SILL DETAIL	A	ZER

HARDWARE GROUP NO. OH-01

For use on Door #(s):

PTB-100B

Provide each door(s) with the following:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	SET	CYLINDER(S)	AS REQ'D BY LOCKING MECHANISM	626	SCH

BALANCE OF HARDWARE PROVIDED BY OVERHEAD DOOR MANUFACTURER.

END OF SECTION

DIVISION 09 FINISHES

SECTION 09 90 02
HIGH PERFORMANCE PAINTING AND COATING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes requirements for providing high performance painting and coating. Includes preparation, cleaning, protection, application and materials for areas that require high performance painting and coating systems.
- B. Related Sections Include:
 - 1. Division 1 – Process Interconnections.
 - 2. Division 3 – Concrete.
 - 3. Division 5 – Metals.
 - 4. Division 40 – Process Interconnections.
 - 5. Division 41 – Material Processing and Handling Equipment.
 - 6. Division 43 – Process Gas and Liquid Handling, Purification and Storage Equipment.
 - 7. Division 46 – Water and Wastewater Equipment.

1.02 REFERENCES

- A. The following is a list of standards which may be referenced in this section:
 - 1. American Water Works Association (AWWA):
 - 2. ANSI/ASTM D16 – Standard Terminology for Paint, Related Coatings, Materials, and Applications.
 - 3. Environmental Protection Agency (EPA).
 - 4. Occupational Safety and Health Act (OSHA).
- B. Current Joint Standards for the Society for Protective Coatings (SPCC)/National Association of Corrosion Engineers International (NACE).
 - 1. Ten States Standards – 54.5 Piping Code.

1.03 DEFINITIONS

- A. Conform to ANSI/ATSM D16 for interpretation of terms used in this Section.

1.04 SUBMITTALS

- A. Submit product data under provisions of Section 01 33 00. Indicate each material and cross-referenced specified coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

- B. Provide Product data on all Products including manufacturer's technical information, label analysis, and instructions for handling, mixing, storing, and applying each coating material. Submit manufacturer's application instructions under provisions of Section 01 33 00.
- C. Provide a paint system data sheet for each coating system, including all components for providing a complete system. Components include surface preparation, primer, intermediate coats, and finish coats.
- D. Provide paint manufacturers certification that proposed coating systems meet specified performance requirements.
- E. Submit five (5) full color sample sheets illustrating available colors for each scheduled surface finish Product. During the shop drawing review process, Engineer and Owner will select color choices for surfaces to be coated. Submit samples under provisions of Section 01 33 00.
- F. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible for each instance.
- G. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details

1.05 QUALITY ASSURANCE

- A. Product Manufacturer: Company specializing in manufacturing quality paints and finish products with minimum ten (10) years' experience.
- B. Applicator: Minimum 10 years' experience in application of specified products.
- C. Regulatory Requirements:
 - 1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
 - 2. Perform surface preparation and painting in accordance with recommendations of the following:
 - a. Paint manufacturer's instructions.
 - b. SSPC PA 3, Guide to Safety in Paint Applications.
 - c. Federal, state, and local agencies having jurisdiction.
- D. Maintain examples of SSPC visual standards on Site.
- E. Provide wet and dry paint thickness measurement instrument on Site.
- F. Specification language for High Performance Coating Systems is based on Sherwin Williams and Tnemec.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the OWNER until required for installation. Materials shall be transported, delivered, stored and handled in accordance with manufacturer's instructions and the requirements of Section 01 61 00.
- B. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.
- C. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.
- D. Take precautionary measures to prevent fire hazards and spontaneous combustion. Removal all paint waste from site daily and dispose of properly.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable state regulations, Environmental Protection Agency, Occupational Health and Safety Administration, Ten States Standards, Uniform Building Code, and Uniform Fire Codes and Standards.
- B. All Products that may come into contact with water intended for use in a Public Water System shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

1.08 THREE YEAR PERFORMANCE GUARANTEE

- A. The quality of both materials and workmanship for the installed coating materials (as defined in this specification) will be the sole responsibility of the Contractor. It is hereby guaranteed that should the coating material delaminate, chip, peel, blister, crack or otherwise fail due to improper surface preparation, improper mixing and application or curing of coating materials or protection of the coating work during cure by the Contractor or due to lack of material quality on the part of the material manufacturer, the Contractor shall repair or replace the damaged or failing coating to Owner's satisfaction at no cost to Owner and at Owner's convenience. Should the existing substrate below the coating fail causing such coating failure, except if related to inadequate surface preparation or coating quality causing substrate corrosion, the Contractor shall not be held liable.
- B. It is further understood by the Contractor that any incompatibility with or error in formulation of the coating materials used on this project, which results in a coating failure, will be a financial matter strictly between the Coating System Manufacturer and the Contractor. The business responsibility and financial

accountability for such a material related failure to Owner would remain solely with the Contractor.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. High Performance Painting and Coating Systems: All paint materials selected for coating systems for each type of system shall be the product of one manufacturer. Acceptable manufacturers are:
 - 1. Tnemec
 - 2. Sherwin-Williams (SW) Industrial Coating
- B. Coating systems of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing coating systems in compliance with the following specification section. Any deviations without sufficient evidence proving equal or superior quality shall be rejected without further review or comment.
- C. Provide manufacturer's best-quality paint material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
- D. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions and obtain approval from Engineer before bidding in accordance with Division 01.

2.02 ABRASIVE MATERIALS

- A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

- A. General:
 - 1. Manufacturer's highest quality products suitable for intended service.
 - 2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Mix only components specified and furnished by paint manufacturer.
5. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph, Shop Coating Requirements.

B. Surface Preparation: Provide Engineer minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment Specifications, such equipment shall be primed and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Engineer may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

1. Ductile Iron Pipe:
 - a. Use SSPC standards as a guide for desired prepared surface.
 - b. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
 - c. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
 - d. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
 - e. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.

- f. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.
- 2. Bituminous coated pipe shall not be allowed for pipe to be field coated.

2.06 SPARES

- A. Furnish small quantity kits (minimum one gallon per product per color) for touchup painting and for painting other small areas.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide Engineer minimum 7 days' advance notice to start of field surface preparation work and coating application work.
- B. Perform the Work only in presence of Engineer, unless Engineer grants prior approval to perform the Work in Engineer's absence.
- C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Engineer.

3.02 ENVIRONMENTAL REQUIREMENTS:

- A. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
- B. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees Fahrenheit above dew point of ambient air.

3.03 EXAMINATION

- A. Factory Finished Items:
 - 1. Review other Section in which primers are provided to ensure compatibility of the total system for various substrates
 - 2. Schedule inspection with Engineer before repairing damaged factory finished items delivered to Site.
 - 3. Test shop applied primer and finishes for compatibility with subsequent coating and covering materials.
 - 4. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.
- B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and

recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.04 PROTECTION OF ITEMS NOT TO BE PAINTED

- A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.
- B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
- C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
- D. Mask openings in motors to prevent paint and other materials from entering.
- E. Protect surfaces adjacent to or downwind of Work area from overspray.
- F. Do not paint stainless steel bolts.

3.05 SURFACE PREPARATION

- A. Field Abrasive Blasting:
 - 1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
 - 2. Refer to coating systems for degree of abrasive blasting required.
 - 3. Where the specified degree of surface preparation differs from manufacturer's recommendations, the more stringent shall apply.
- B. Metal Surface Preparation:
 - 1. Where indicated, meet requirements of SSPC Specifications summarized below:
 - a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
 - b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
 - c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, sing power-assisted hand tools.
 - d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.

- e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
 - f. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
- 2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning” or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC specification.
 - 3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.
 - 4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.
 - 5. Hand tool clean areas that cannot be cleaned by power tool cleaning.
 - 6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.
 - 7. Welds and Adjacent Areas:
 - a. Prepare such that there is:
 - 1) No undercutting or reverse ridges on weld bead.
 - 2) No weld spatter on or adjacent to weld or any area to be painted.
 - 3) No sharp peaks or ridges along weld bead.
 - b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.
 - 8. Preblast Cleaning Requirements:
 - a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.
 - b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.
 - c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.
 - 9. Blast Cleaning Requirements:

- a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
 - b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
 - c. Use only dry blast cleaning methods.
 - d. Do not reuse abrasive, except for designed recyclable systems.
 - e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
- 10. Post-Blast Cleaning and Other Cleaning Requirements:
 - a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
- C. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.
- D. Ductile and Cast Iron:
 - 1. 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 adhered annealing oxide may remain.
 - 2. Bituminous coated pipe shall NOT be allowed if field painting is required.
 - 3. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and other contaminants.
 - 4. Shop prime exposed pipe with Tnemec Series 1 or SW Corothane 1 Glavapac at 2.5 to 3.5 mils DFT.
 - 5. For ductile and cast iron pipe scheduled for insulative acrylic coating, prepare surface as above and shop prime with Tnemec Series 1224 or SW Macropoxy 646 at 4.0 to 8.0 DFT.
 - 6. Field preparation, primer, intermediate, and top coat as specified herein to be performed by Division 09 contractor.
 - 7. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
- E. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:
 - 1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
- F. Remove oil and grease by wiping or scrubbing surface with suitable solvent, rag, and brush. Use clean solvent and clean rag for final wiping to avoid contaminating surface.

1. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

3.06 CONCRETE SURFACE PREPARATION:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Voids and other defects that are at or near the surface shall be exposed during surface preparation.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Engineer, surface may be cleaned by acid etching method. Approval is subject to producing desired profile as listed in section 3.07 below based on the required coating system. If not specifying, surface profile to the equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed. Coordinate blast clean with buffing requirements provided in Division 03 – Concrete.
5. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
6. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
7. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

B. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

C. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
 - a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
 - b. Brush-off blasting.
 - c. Water blasting.

4. Do not damage masonry mortar joints or adjacent surfaces.
 5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
 6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
 7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.
- D. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.
1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

3.07 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.
3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Engineer will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
 - a. Rate: Approximately 2 gallons per 100 square feet.
 - b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained. c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
 - c. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
 - d. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.

3. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
4. Ensure surface is completely dry before application of coating.
5. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.

C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.08 APPLICATION

A. General:

1. In general, all new and modified existing structures and items, whether specifically mentioned or not, shall be painted, unless otherwise noted. Do not paint exterior concrete surfaces, unless specifically indicated.
 - a. Interior concrete walls, floors, and ceilings within the facility.
 - b. Interior concrete block masonry within the facility and modified concrete block masonry.
 - c. All new doors and frames and window frames (if required) within the expanded facility.
 - d. Exterior, interior, and submerged ferrous metals.
 - e. Miscellaneous other metals.
 - f. Paint shop-primed equipment and fixtures.
 - g. Unfinished louvers, grilles, covers, and access panels on mechanical and electrical components; paint separately.
 - h. Prime and paint all surfaces located behind, underneath, or otherwise previously obstructed by items that have been removed or demolished.
 - i. Prime and paint all surfaces of new process pipes (non-insulated and insulated), electrical conduit, valves, fittings, meters, boxes, hangers, brackets, collars, and supports, except where items are prefinished.
 - j. Paint discharge heads and base plates of all new or modified pumps.
 - k. Prime and paint all new unburied exterior steel, ductile, galvanized, and PVC piping.
 - l. Replace identification markings on mechanical or electrical equipment when painted accidentally.
 - m. Paint exposed conduit and electrical equipment occurring in finished areas.
 - n. Paint both sides and edges of plywood backboards for electrical equipment before installing equipment.

- o. Replace electrical plates, hardware, light fixture trim, and fittings removed prior to finishing.
 - p. All surfaces not specifically excluded.
 - 2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
- B. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
- 1. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
 - 2. Apply a stripe coat of an approved coating system via brush or roller to all weld seams, edges, angles, and mechanical connections. Stripe coat shall be applied after primer coat and be of a different color than the primer coat.
 - 3. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
 - 4. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
 - 5. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
- C. Keep paint materials sealed when not in use.
- 1. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.
- D. Galvanized Metal, Copper, and Nonferrous Metal Alloys:
- 1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
 - 2. Prepare surface and apply primer in accordance with Protective Coating System specification.
 - 3. Apply intermediate and finish coats of the coating system appropriate for the exposure.
- E. Porous Surfaces, Such as Concrete and Masonry:
- 1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids and defects with any

dimension greater than 1/4-inch with manufacturer recommended filler. This requirement applies to porous surfaces scheduled to receive coatings as well as to porous surfaces that are not scheduled to receive additional coatings. Coordinate with Division 03 Contractor.

2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
 - a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.
3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

F. Film Thickness and Coverage:

1. Number of Coats:
 - a. Minimum required without regard to coating thickness.
 - b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
 - a. Follow coating manufacturer's recommendations.
 - b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
 - a. Perform with properly calibrated instruments.
 - b. Recoat and repair as necessary for compliance with Specification.
 - c. Coats are subject to inspection by Engineer and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.09 HIGH PERFORMANCE COATINGS SYSTEMS AND APPLICATION SCHEDULE

- A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.
- B. Additional requirements are included in the Piping Schedule or in Piping Specifications.

C. System No. 1: Ferrous Metals, Exterior Exposure, Non immersion

System Type	Surface Preparation	Primer Coat 3.0 to 5.0 DFT	Intermediate Coat	Topcoat, 2.0 to 3.0 DFT
Polyamidoamine	SPCC SP6	Tnemec Series N69, SW Macropoxy 646	NA	Tnemec Series 1075, SW Acrolon 218

1. Use two coat coating system for maintenance coating of structural steel. For non-immersed, non-corrosive environments.
2. Use on new exposed metal surfaces, located outside of structures, including structural steel, metal decking, guard posts, hollow metal doors and frames, piping, equipment, and miscellaneous metal.

D. System No. 2: Ferrous Metals, Interior Exposure, Non-Immersion

System Type	Surface Preparation	Primer Coat, 3.0 to 5.0 DFT	Intermediate Coat	Topcoat, 3.0 to 5.0 DFT
Polyamidoamine	SPCC SP10	Tnemec Series N69, SW Duraplate 235 MPE	NA	Tnemec Series N69, SW Duraplate 235 MPE

1. For interior two coat coating system for coating of carbon steel and other ferrous metals. For non-immersed, mildly corrosive splash/spill and wet environments.
2. For exposed metal surfaces located inside of structures, exposed to weather or in a highly humid atmosphere, such as pipe galleries, and for the specific surfaces:
 - a. Exterior surfaces of process pipes. All pipes scheduled to be insulated must be painted prior to providing insulation.
 - b. Exterior surface of valves.
 - c. Exterior surface of equipment not shop finished, per manufacturer's instructions.
3. Pipe supports, excluding stainless and galvanized steel.
 - a. Use on new exposed metal surfaces, interior exposure, including structural steel, metal decking, guard posts, hollow metal doors and frames, mechanical, electrical, piping, equipment, and miscellaneous metal.

E. System No. 3: Ferrous Metals, Immersion

System Type	Surface Preparation	Primer Coat, 3.0 to 5.0 DFT	Intermediate Coat	Topcoat, 3.0 to 5.0 DFT
Polyamidoamine	SPCC SP10	Tnemec Series N69, SW Duraplate 235 MPE	NA	Tnemec Series N69, SW Duraplate 235 MPE

1. Verify with manufacturer a compatible field tie-in coat for shop primed items where applicable.
2. Use on immersed metal surfaces, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, structural steel, and surfaces of steel piping.
 - a. Submerged, partially submerged and splash area metals not shop finished.

F. System No. 4: Ferrous Metals, Immersion and/or H₂S Exposure

System Type	Surface Preparation	Primer Coat	Intermediate Coat	Topcoat
Modified Polyamine Epoxy	SPCC SP 10	Self Priming	Tnemec Series 435 (15.0 to 20.0 mils DFT), SW Duraplate 5900 (15.0 to 20.0 mils DFT)	Tnemec Series 435 (15.0 to 20.0 mils DFT), SW Duraplate 5900 (15.0 to 20.0 mils DFT)

1. Use on immersed metal surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel, and interior surfaces of steel piping in areas with potential H₂S exposure.
2. Scheduled for:
Not Used.

G. System No. 5: Metals, Buried and/or Below Grade

System Type	Surface Preparation	Primer Coat, 3.0 to 5.0 mils DFT	Intermediate Coat	Topcoat, 16.0 to 20.0 mil DFT
Coal tar epoxy	SPCC SP10	Tnemec Series N69 (optional), SW Macropoxy 646 (optional)	NA	Tnemec Series 46H-413, SW Hi-Mil Sher-Tar Epoxy

1. For steel pipe and fittings, follow AWWA C209 and AWWA C214 with outer wrap.
2. For buried, below grade portions of metal items, except buried stainless steel, and the follow specific surfaces:
 - a. Fasteners and accessories for buried piping
 - b. Buried Valves

H. System No. 6: Metals, Concrete Embedded and Encased

System Type	Surface Preparation	Primer Coat	Intermediate Coat, 8.0 to 10.0 mils DFT	Topcoat, 8.0 to 10.0 mils DFT
Coal tar epoxy	SPCC SP6	NA	Tnemec Series 46H-413, SW Hi-Mil Sher-Tar Epoxy	Tnemec Series 46H-413, SW Hi-Mil Sher-Tar Epoxy

1. For concrete embedded and encased surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles.

I. System No. 7: Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

System Type	Surface Preparation	Primer Coat, 3.0 to 5.0 mils DFT	Intermediate Coat	Topcoat, 3.0 to 5.0 mils DFT
Epoxy Polyamide	Abrasive brush blast to create a 1.5 mil profile	Tnemec Series N69, SW Macropoxy 646	NA	Tnemec Series N69, SW Macropoxy 646

1. Verify with manufacturer compatibility as a field tie-in coat.
2. Use on the following items or areas:
 - a. Galvanized surfaces requiring painting.
 - b. After application of System No. 7, apply System No. 1 topcoat for exterior, System No. 3 topcoat for interior.

J. System No. 8: PVC, CPVC and FRP, Exposed

System Type	Surface Preparation	Primer Coat, 2.0 to 4.0 mils DFT	Intermediate Coat	Topcoat, 2.0 to 4.0 mils DFT
Polyamidoamine	Scarify	Tnemec Series N69, SW Macropoxy 646	NA	Tnemec Series 1075, SW Acrolon 218

1. For use on exposed PVC, CPVC, and FRP.

K. System No. 9: Insulated Pipe, Exposed:

System Type	Surface Preparation	Primer Coat, 2.0 to 3.0 mils DFT	Intermediate Coat	Topcoat, 2.0 to 3.0 mils DFT
Acrylic	Clean and Dry	Tnemec Series 6, SW DTM primer/finish	NA	Tnemec Series 6, SW DTM primer/finish

1. For use on insulation of insulated pipes.
2. Coat pipes with appropriate coating system before insulating.

L. System No. 10: Concrete, Precast and Poured in Place, Immersion, Light H₂S Vapor:

System Type	Surface Preparation	Primer Coat 3.0 to 5.0 mils DFT	Intermediate Coat	Topcoat, 3.0 to 5.0 mils DFT
Polyamidoamine	SPCC SP13, ICRI CSP2-3	Tnemec Series N69, SW Duraplate 235 MPE	NA	Tnemec Series N69, SW Duraplate 235 MPE

1. Prep surface in accordance with concrete surface preparation.

2. For use on walls and ceilings in areas with light to moderate H₂S exposure.
3. Scheduled for:
 - a. New and repaired concrete in Secondary Treatment (ST) sludge holding tanks.
 - b. Repaired concrete in Secondary Treatment (ST) existing/modified clarifier.
 - c. New concrete in Secondary Treatment (ST) aeration tanks and clarifier tank, top of wall to 1 ft below ordinary water level.
 - d. New concrete in splitter structure, top of wall to 1 ft below ordinary water level.

M. System No. 11: Concrete, Precast and Poured in Place, Immersion, High H₂S

System Type	Surface Preparation	Primer Coat (to reduce offgassing)	Intermediate Coat	Topcoat
Modified Polyamine Epoxy	SPCC SP13, ICRI CSP3-5, apply filler as required	Tnemec Mortarclad 218 (1/16" to 1/8"), SW Corobond 100 (4 to 6 mils)	Tnemec Series 435 (20.0 to 30.0 mils DFT), Duraplate 5900 (20.0 to 30.0 mils DFT)	Tnemec Series 435 (20.0 to 30.0 mils DFT), Duraplate 5900 (20.0 to 30.0 mils DFT)

1. Prep surface in accordance with concrete surface preparation.
2. For use on walls and ceilings in areas with moderate to heavy H₂S exposure.
3. Schedule for:
Not Used.

N. System No. 12: Concrete, Precast and Poured in Place, Immersion, no H₂S exposure

System Type	Surface Preparation	Primer Coat	Intermediate Coat	Topcoat,
		3.0 to 5.0 mils DFT		3.0 to 5.0 mils DFT
Polyamidoamine	SPCC SP13 ICRI CSP2-4	Tnemec Series N69, SW Duraplate 235 MPE	NA	Tnemec Series N69, SW Duraplate 235 MPE

1. Prep surface in accordance with concrete surface preparation.
2. For use on floors, walls and ceilings in areas with no to minimal H₂S exposure.
3. Scheduled for:

Not Used.

O. System No. 13: Concrete Secondary Containment, Chemical Resistant Paint

System Type	Surface Preparation	Primer Coat, Per Mnfr recommendation	Intermediate Coat Per Mnfr recommendation	Topcoat Per Mnfr recommendation
Epoxy	SPCC SP13 ICRI CSP5	Tnemec Series 218, SW Corobond 300 resurfacer	Tnemec Series 104, SW Sherglass FF	Tnemec Series 104 SW Sherglass FF

P. Prep surface in accordance with concrete surface preparation.

1. For use on floors and walls in secondary containment basins.
2. Scheduled for:
Not Used.

Q. System No. 14: Aluminum and Dissimilar Metal Insulation:

System Type	Surface Preparation	Primer Coat	Intermediate Coat	Topcoat
Bituminous	Abrasive blast to provide a 3.0 mil angular anchor profile	NA	NA	Tnemec Series 46H-413, SW Hi-Mil Sher-Tar Epoxy

1. Use on aluminum surfaces embedded or in contact with concrete and for dissimilar metal insulation.

3.10 COLORS

- A. Provide as designated herein and shown in Piping Schedule or as selected by Engineer.
- B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.
- C. Equipment Colors:
 1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.
 2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
 - a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
 - b. Fire Protection Equipment and Apparatus: OSHA Red.
 - c. Radiation Hazards: OSHA Purple.

- d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

- 1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
- 2. Pipe Color Coding: In accordance with the "Recommended Standards For Wastewater Facilities" and as specified in Section 40 27 00.
- 3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
- 4. Pipe Supports: Painted light gray, as approved by Engineer.

3.11 FIELD QUALITY CONTROL

- A. Sharp edges, weld spatter, scab marks, and other imperfections shall be ground to a smooth radius or removed and re-blasted before coating application.

B. Testing:

- 1. Thickness and Continuity Testing:
 - a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
 - b. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Engineer.

- C. Inspection: Leave staging and lighting in place until Engineer has inspected surface or coating. Replace staging removed prior to approval by Engineer.

- 1. Provide additional staging and lighting as requested by Engineer.

D. Unsatisfactory Application:

- 1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
- 2. Evidence of runs, bridges, holidays, laps, or other imperfections is cause for rejection.

3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Feather edges and repair in accordance with recommendations of paint manufacturer.
2. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather the edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
3. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.12 MANUFACTURER'S SERVICES

- A. In accordance with Section 01 45 00, Manufacturers' Field Services, coating manufacturer's representative shall be present at Site as follows:
1. On first day of application of any coating system.
 2. A minimum of two additional Site inspection visits, each for a minimum of 4 hours, in order to provide Manufacturer's Certificate of Proper Installation.
 3. As required to resolve field problems attributable to or associated with manufacturer's product.
 4. To verify full cure of coating prior to coated surfaces being placed into immersion service.

3.13 CLEANUP

- A. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.
- B. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

END OF SECTION 09 90 02

DIVISION 10 SPECIALTIES

SECTION 10 44 16

FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes portable, hand-carried fire extinguishers.

1.02 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.
- B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.
- C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.03 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

1.04 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

PART 2 - PRODUCTS

2.01 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. J. L. Industries, Inc.; a division of Activar Construction Products Group.
 - b. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
 - c. Larsen's Manufacturing Company.
 - d. Potter Roemer LLC.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

- A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. Provide one extinguisher hanger and "Fire Extinguisher" wall decal per extinguisher

END OF SECTION

DIVISION 22

PLUMBING

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.

1.02 RELATED REQUIREMENTS

- A. Section 09 91 23 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems; 2023.

PART 2 - PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE

- A. Nameplates:
 - 1. Heat exchangers, water heaters, and other heat transfer products.
 - 2. Control panels, transducers, and other related control equipment products.
 - 3. Pumps, tanks, filters, water treatment devices, and other plumbing equipment products.
- B. Pipe Markers: 3/4 inch (20 mm) diameter and higher.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
 - 2. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
- B. Description: Laminated piece with up to three lines of text.
 - 1. Letter Color: Black.
 - 2. Letter Height: 1/2 inch (13 mm).

2.03 TAGS

- A. Manufacturers:

1. Advanced Graphic Engraving; _____: www.advancedgraphicengraving.com/#sle.
 2. Brady Corporation; _____: www.bradycorp.com/#sle.
 3. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
 4. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.
 5. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
 6. Seton Identification Products; _____: www.seton.com/#sle.
- B. Flexible: Vinyl with engraved black letters on light contrasting background color with up to three lines of text. Minimum tag size 1-1/2 inch (40 mm) in diameter.

2.04 PIPE MARKERS

- A. Manufacturers:
1. Brady Corporation; _____: www.bradycorp.com/#sle.
 2. Brimar Industries, Inc; _____: www.pipemarker.com/#sle.
 3. Craftmark Pipe Markers; _____: www.craftmarkid.com/#sle.
 4. Kolbi Pipe Marker Co; _____: www.kolbipipemarkers.com/#sle.
 5. Seton Identification Products; _____: www.seton.com/#sle.
- B. Identification Scheme, ASME A13.1:
1. Primary: External Pipe Diameter, Uninsulated or Insulated.
 - a. 3/4 to 1-1/4 inches (19 to 32 mm): Use 8 inch (203 mm) field-length with 1/2 inch (13 mm) text height.
 - b. 1-1/2 to 2 inches (38 to 51 mm): Use 8 inch (203 mm) field-length with 3/4 inch (19 mm) text height.
 - c. 2-1/2 to 6 inches (64 to 152 mm): Use 12 inch (305 mm) field-length with 1-1/4 inch (32 mm) text height.
 2. Secondary: Color scheme per fluid service.
 - a. Water; Potable, Cooling, Boiler Feed, and Other: White text on green background.
 3. Tertiary: Other Details.
 - a. Directional flow arrow.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive identification products.
- B. Prepare surfaces for stencil painting, see Section 09 91 23.

3.02 INSTALLATION

- A. Install flexible nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

- B. Install tags in clear view and align with axis of piping
- C. Install plastic tape pipe marker around pipe in accordance with manufacturer's instructions.
- D. Apply ASME A13.1 Pipe Marking Rules:
 - 1. Place pipe marker adjacent to changes in direction.
 - 2. Place pipe marker adjacent each valve port and flange end.
 - 3. Place pipe marker at both sides of floor and wall penetrations.
 - 4. Place pipe marker every 25 to 50 feet (7.6 to 15.2 m) interval of straight run.

END OF SECTION 22 05 53

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SECTION 22 10 05
PLUMBING PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Sanitary waste piping, buried within 5 feet (1500 mm) of building.
- B. Sanitary waste piping, above grade.
- C. Domestic water piping, buried within 5 feet (1500 mm) of building.
- D. Domestic water piping, above grade.
- E. Propane gas piping, above grade.
- F. Natural gas piping, above grade.
- G. Pipe hangers and supports.

1.02 REFERENCE STANDARDS

- A. ANSI LC 1/CSA 6.26 - Fuel Gas Piping Systems Using Corrugated Stainless Steel Tubing; 2023.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2021.
- C. ASME B31.1 - Power Piping; 2024.
- D. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2024.
- E. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2025.
- F. ASTM D2239 - Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter; 2025.
- G. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems; 2020 (Reapproved 2024).
- H. ASTM D2609 - Standard Specification for Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe; 2024.
- I. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings; 2025.
- J. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl

Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets; 2020 (Reapproved 2024).

- K. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings; 2024, with Editorial Revision (2025).
- L. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- M. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2025.
- N. NFPA 58 - Liquefied Petroleum Gas Code; 2024, with Amendment.
- O. NSF 61 - Drinking Water System Components - Health Effects; 2025, with Addendum
- P. NSF 372 - Drinking Water System Components - Lead Content; 2024.

1.03 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide Aquatherm Green polypropylene-random (PP-R/PP-RCT) fusion-welded piping and fittings conforming to ASTM F2389. Pipe and fittings intended for potable water service shall comply with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372 for drinking water system components and lead content. Join pipe and fittings by heat fusion in accordance with the manufacturer's written instructions. Provide pipe and fittings manufactured and supplied by the same manufacturer. Label piping and fittings for identification.
- B. Non-Potable Water Piping Systems: Provide Aquatherm Blue polypropylene-random (PP-R/PP-RCT) fusion-welded piping and fittings conforming to ASTM F2389. Join pipe and fittings by heat fusion in accordance with the manufacturer's written instructions. Provide pipe and fittings manufactured and supplied by the same manufacturer. Label piping and fittings for identification.

2.02 SANITARY WASTE PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

- A. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY WASTE PIPING, ABOVE GRADE

A. PVC Pipe: ASTM D2665.

1. Fittings: PVC.
2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. PE Pipe: ASTM D2239.

1. Fittings: ASTM D2609, PE.
2. Joints: Mechanical with stainless steel clamp.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

A. POTABLE WATER - AQUATHERM GREEN - PP-R/PP-RCT Pipe: ASTM F2389.

1. Fittings: ASTM F2389, PP-R/PP-RCT.
2. Joints: Heat-fusion welded in accordance with the manufacturer's written instructions.

B. NON-POTABLE WATER - AQUATHERM BLUE - PP-R/PP-RCT Pipe: ASTM F2389.

1. Fittings: ASTM F2389, PP-R/PP-RCT.
2. Joints: Heat-fusion welded in accordance with the manufacturer's written instructions.

2.06 PROPANE GAS PIPING, ABOVE GRADE

A. Steel Pipe: ASTM A53/A53M, Grade B, Type F, Schedule 40 black.

1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
2. Joints: NFPA 58, threaded or welded to comply with ASME B31.1.

B. Flexible Gas Piping:

1. Corrugated Stainless Steel Tubing: Comply with ANSI LC 1/CSA 6.26.
2. Comply with ASTM E84.
3. Fittings: Provided by piping system manufacturer.

2.07 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.

1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Drain, Waste, and Vent:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm, DN): Stainless Steel, adjustable swivel, split ring.
 2. Hangers for Pipe Sizes 2 inch (50 mm, DN) and Over: Stainless steel, adjustable, clevis.
- C. Plumbing Piping - Water:
1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (15 to 40 mm, DN): Stainless Steel, adjustable swivel, split ring.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- C. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- D. Establish elevations of buried piping outside the building to ensure not less than 4ft of cover.
- E. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- F. PP-R/PP-RCT Pipe and Fittings: Make heat-fusion joints in accordance with ASTM F2389 and the manufacturer's written instructions using fusion equipment recommended by the pipe manufacturer. Complete all joints using trained personnel and procedures that produce a homogeneous, leak-free joint. For potable water systems, use pipe and fittings complying with NSF/ANSI/CAN 61 and NSF/ANSI/CAN 372.
- G. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
- H. Sleeve pipes passing through partitions, walls, and floors.

I. Pipe Hangers and Supports:

1. Support horizontal piping as indicated.
2. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.
3. Place hangers within 12 inches (300 mm) of each horizontal elbow.
4. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment.
Design hangers for pipe movement without disengagement of supported pipe.
5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
6. Provide copper plated hangers and supports for copper piping.

J. Pipe Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
3. Locate piping in center of sleeve or penetration.
4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
5. Tighten bolting for a watertight seal.
6. Install in accordance with manufacturer's recommendations.

K. Where piping penetrates fire-resistance-rated floors, walls, shafts, and smoke barriers, provide firestopping systems tested and listed for the specific penetrating item and assembly.

L. Firestop systems shall be installed in accordance with the manufacturer's published instructions and the requirements of Division 07 Firestopping.

M. Maintain the fire-resistance rating and smoke-resistance characteristics of the penetrated assembly.

3.03 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/8 inch per foot (1:100) slope.

3.04 SCHEDULES

A. Pipe Hanger Spacing:

1. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum Hanger Spacing: 6 ft (1.8 m).

- 2) Hanger Rod Diameter: 3/8 inch (9 mm).

END OF SECTION 22 10 05

DIVISION 23 HEATING, VENTILATING, AND AIR CONDITIONING

SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic systems.

1.02 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition; 2016.
- B. ASHRAE Std 110 - Methods of Testing Performance of Laboratory Fume Hoods; 2016 (Reaffirmed 2025).
- C. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2024, with Errata (2025).
- D. NEBB (TAB) - Procedural Standard for Testing, Adjusting and Balancing of Environmental Systems; 2019, with Errata (2022).
- E. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2023.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:

1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 2. Having minimum of three years documented experience.
 3. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
1. Systems are started and operating in a safe and normal condition.
 2. Temperature control systems are installed complete and operable.
 3. Proper thermal overload protection is in place for electrical equipment.
 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 5. Duct systems are clean of debris.
 6. Fans are rotating correctly.
 7. Fire and volume dampers are in place and open.
 8. Air coil fins are cleaned and combed.
 9. Access doors are closed and duct end caps are in place.
 10. Air outlets are installed and connected.
 11. Duct system leakage is minimized.
 12. Hydronic systems are flushed, filled, and vented.
 13. Pumps are rotating correctly.
 14. Proper strainer baskets are clean and in place.
 15. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

3.03 PREPARATION

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

- C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- E. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- F. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

- G. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- H. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.

3.08 SCOPE

- A. Test, adjust, and balance the following:
 - 1. HVAC Pumps.
 - 2. Packaged Roof Top Heating/Cooling Units.
 - 3. Air Coils.
 - 4. Fans.
 - 5. VAV Boxes
 - 6. Grilles, Registers, Diffusers
 - 7. Radiant Floor Heat
 - 8. Hot water Unit Heaters
 - 9. Make-up Air Unit(s)

END OF SECTION 23 05 93

SECTION 23 07 13
DUCT INSULATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.

1.02 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus; 2021.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications; 2024.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

PART 2 - PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K (Ksi) value: 0.36 at 75 degrees F (0.052 at 24 degrees C), when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 250 degrees F (121 degrees C).
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- B. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Secure with pressure-sensitive tape.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.02 SCHEDULES

- A. Exposed Supply Duct: No insulation.
- B. Exposed Exhaust Duct: No insulation.
- C. Outside Air Intake Ducts: Insulate in their entirety. Provide 2.2" of glass fiber blanket with vapor barrier.

END OF SECTION 23 07 13

SECTION 23 23 00
REFRIGERANT PIPING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Piping.

1.02 REFERENCE STANDARDS

- A. AHRI 710 (I-P) - Performance Rating of Liquid-Line Driers; 2009.
- B. AHRI 711 (SI) - Performance Rating of Liquid-Line Driers; 2009.
- C. ASME B31.9 - Building Services Piping; 2025.
- D. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service; 2023.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- F. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

2.02 REGULATORY REQUIREMENTS

- A. Comply with ASME B31.9 for installation of piping system.

2.03 PIPING

- A. Preinsulated Refrigerant Piping Linesets:
 - 1. Copper Tube: ASTM B280 seamless, anticorrosion pipe; lineset is precoupled to include two joined pipes.
 - 2. Insulation: Polyethylene closed-cell foam; preapplied to entire length of lineset. Weather- and UV-resistant for outdoor installation. Maximum flame spread index of 25 and maximum smoke developed index of 50, when tested in accordance with ASTM E84 or UL 723.

END OF SECTION 23 23 00

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SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Metal ducts.

1.02 REFERENCE STANDARDS

- A. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2023.
- B. ASTM A666/A666M - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar; 2024.
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2020.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Provide UL Class 1 ductwork, fittings, hangers, supports, and appurtenances in accordance with NFPA 90A and SMACNA (DCS) guidelines unless stated otherwise.
- B. Provide metal duct unless otherwise indicated.
- C. Duct Shape and Material in accordance with Allowed Static Pressure Range:
 - 1. Round: Plus or minus 2 in-wc (500 Pa) of galvanized steel.
 - 2. Rectangular: Plus or minus 1/2 in-wc (125 Pa) of galvanized steel.
 - 3. Rectangular: Plus or minus 1/2 in-wc (125 Pa) of Aluminum.
- D. Duct Sealing and Leakage in accordance with Static Pressure Class:
 - 1. Duct Pressure Class and Material for Common Mechanical Ventilation Applications:
 - a. Supply Air: 1/2 in-wc (125 Pa) pressure class, Stainless Steel.
 - b. Outside Air Intake: 1/2 in-wc (125 Pa) pressure class, Stainless Steel.
 - c. General Exhaust Air: 1/2 in-wc (125 Pa) pressure class, Stainless Steel.
 - 2. Low Pressure Service: Up to 2 in-wc (500 Pa):

- a. Seal: Class C, apply to seal off transverse joints.
- b. Leakage:
 - 1) Rectangular: Class 24 or 24 cfm/100 sq ft (680 Lpm/9.3 sq m).
 - 2) Round: Class 12 or 12 cfm/100 sq ft (340 Lpm/9.3 sq m).

E. Duct Fabrication Requirements:

- 1. Duct and Fitting Fabrication and Support: SMACNA (DCS) including specifics for continuously welded round and oval duct fittings.
- 2. Use reinforced and sealed sheet-metal materials at recommended gauges for indicated operating pressures or pressure class.
- 3. Construct tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide airfoil turning vanes of perforated metal with glass fiber insulation.
- 4. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- 5. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- 6. Provide turning vanes of perforated metal with glass fiber insulation when an acoustical lining is required.
- 7. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.02 METAL DUCTS

A. Material Requirements:

- 1. Stainless Steel: ASTM A666, Type 316.

B. Rectangular Metal Duct:

- 1. Rectangular Single Wall: Rectangular, longitudinal lock seam duct with stainless steel wall.

C. Round Metal Ducts:

- 1. Round Single Wall Duct: Round lock seam duct with stainless steel outer wall.
- 2. Round Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Duct sizes indicated are precise inside dimensions. For lined ducts, maintain sizes inside lining.
- C. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

3.02 SCHEDULES

- A. All ductwork: 316L Stainless Steel.

END OF SECTION 23 31 00

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SECTION 23 34 23
HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.
- B. Wall exhausters.

1.02 REFERENCE STANDARDS

- A. AMCA (DIR) - (Directory of) Products Licensed Under AMCA International Certified Ratings Program; 2015.
- B. AMCA 99 - Standards Handbook; 2025.
- C. AMCA 204 - Balance Quality and Vibration Levels for Fans; 2020.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating; 2025.
- E. AMCA 300 - Reverberation Room Methods of Sound Testing of Fans; 2024.
- F. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data; 2022.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Greenheck Fan Corporation: www.greenheck.com/#sle.
- B. Loren Cook Company: www.lorencook.com/#sle.
- C. Twin City Fan & Blower: www.tcf.com/#sle.

2.02 POWER VENTILATORS - GENERAL

- A. Static and Dynamically Balanced: Comply with AMCA 204.
- B. Performance Ratings: Comply with AMCA 210, bearing certified rating seal.
- C. Sound Ratings: Comply with AMCA 301, tested to AMCA 300, bearing certified sound ratings seal.
- D. Fabrication: Comply with AMCA 99.

- E. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.03 ROOF EXHAUSTERS

- A. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch (13 mm) mesh, 0.62 inch (1.6 mm) thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- B. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm gets attained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 WALL EXHAUSTERS

- A. Fan Unit: direct driven EC motor with spun aluminum housing; resiliently mounted motor; 1/2 inch (13 mm) mesh, 0.062 inch (1.6 mm) thick aluminum wire bird screen.
- B. Backdraft Damper: Gravity actuated, aluminum multiple blade construction, felt edged with offset hinge pin, nylon bearings, blades linked, and line voltage motor drive, power open, spring return.
- C. Performance Ratings: As indicated on drawings.
- D. Explosion Proof Construction.
- E. Heresite Coating: Entire Unit.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure wall exhausters with stainless steel lag screws to structure.
- C. Extend ducts to wall exhausters into structure. Counterflash duct to wall opening.

END OF SECTION 23 34 23

SECTION 23 74 33
DEDICATED OUTDOOR AIR UNITS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Direct fired make-up air heater.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Titan
- B. Greenheck: www.greenheck.com/#sle.

2.02 INDOOR MOUNTED DIRECT FIRED GAS MAKE-UP AIR UNIT

A. Casing and Components

1. A. Unit shall be factory assembled, pre-piped, pre-wired, ETL listed, and factory tested prior to shipment. Unit shall be indoor horizontal configuration and propane-fired.
2. Casing shall be constructed of minimum 18-gauge G-90 galvanized steel with reinforced framing designed to prevent excessive deflection and vibration during operation. Access doors shall be gasketed and provided for service of filters, fan, burner, controls, and drive components.
3. All interior and exterior cabinet surfaces, including access doors, shall receive a factory-applied Heresite protective coating suitable for corrosive wastewater treatment plant environments. Coating shall be applied in accordance with the coating manufacturer's recommendations and shall provide continuous corrosion protection for all exposed metal surfaces.
4. Electrical components and gas train shall be mounted within an integral service vestibule isolated from the process airstream.
5. Unit Shall Include:
 - a. 36-inch-high structural support stand.
 - b. Low-leak outdoor air damper with factory-mounted electric actuator.
 - c. Factory-installed blower and motor isolation utilizing minimum 1-inch spring isolators.
 - d. Extended bearing grease lines terminating at an accessible location outside the fan section.
 - e. Pillow block fan shaft bearings with regreasable fittings.
 - f. Factory-installed outside air filter section.

B. Insulation

1. Unit casing shall be double-wall construction with minimum 2-inch-thick fiberglass insulation completely enclosed between inner and outer metal liners.
2. Insulation shall have a maximum flame spread index of 25 and smoke developed index of 50 when tested in accordance with ASTM E84.
3. No insulation shall be exposed to the airstream.

C. External Surface Finish

1. Exterior cabinet surfaces shall receive a factory-applied Heresite baked phenolic coating after fabrication to provide corrosion resistance in wastewater treatment plant environments.
2. Repair field damage using Heresite-approved touch-up materials in accordance with the coating manufacturer's recommendations.

D. Filter Section

1. Provide factory-installed V-bank filter section located upstream of the heating section.
2. Filters shall be 2-inch pleated disposable filters with a minimum efficiency of MERV 8 when tested in accordance with ASHRAE Standard 52.2.
3. Filter racks shall provide positive sealing around the filter perimeter to minimize air bypass.
4. Filter section shall be provided with removable access door for filter replacement.

E. Direct-Fired Heating Section

1. Heating section shall consist of a factory-installed, ETL-listed, direct-fired, modulating gas burner certified to ANSI Z83.4/CSA 3.7.
2. Burner shall be designed and factory adjusted for liquefied petroleum gas (propane) operation.
3. Burner shall include:
 - a. Electronic flame safeguard.
 - b. Direct spark ignition.
 - c. Flame rectification.
 - d. High gas pressure safety switch.
 - e. Inlet duct high-temperature limit switch.
 - f. Automatic pre-purge and post-purge sequence.
 - g. Low-fire start sequence.
 - h. Airflow proving interlock.
 - i. Redundant automatic safety shutoff valves.
 - j. Manual gas shutoff valve and gas pressure regulator.
4. Burner shall modulate to maintain the discharge air temperature setpoint over the scheduled operating range.
5. Safety controls shall automatically shut down the burner upon loss of airflow, flame failure, abnormal gas pressure, or activation of any high-

temperature safety device. Manual reset shall be required where applicable.

F. Fan Section

1. Supply fan shall be belt-driven centrifugal type statically and dynamically balanced.
2. Fan shaft shall be supported by regreasable pillow block bearings.
3. Fan assembly shall be mounted on minimum 1-inch spring vibration isolators.
4. Provide extended grease lines terminating outside the fan compartment for routine maintenance.
5. Fan motor shall be controlled by a factory-mounted variable frequency drive complete with factory-supplied ventilation package.

G. Unit Controls

1. Provide a factory-furnished NEMA 1 control panel, shipped loose for field mounting and field wiring.
2. Control panel shall include:
 - a. Door-interlocked non-fused disconnect switch.
 - b. Burner management controls.
 - c. Low-fire start sequence.
 - d. High gas pressure switch monitoring.
 - e. Inlet duct high-temperature limit monitoring.
 - f. Airflow proving relay.
 - g. Fan control relay.
 - h. Terminal strip for field wiring.
3. Unit shall provide the following control functions:
 - a. Start/stop control of the supply fan.
 - b. Modulating discharge air temperature control.
 - c. Relay output to enable the associated exhaust fan upon proof of airflow.
 - d. Low-speed enable input via field-installed High/Low selector switch.
 - e. High-speed enable input via field-installed High/Low selector switch.
 - f. Automatic burner shutdown upon loss of airflow, flame failure, abnormal gas pressure, or high-temperature limit.
4. Factory control panel shall provide dry contacts for unit run status and common alarm for connection to the Building Automation System.
5. Provide factory VFD for fan speed control.

END OF SECTION 23 74 33

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SECTION 23 81 26.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Air-source heat pumps.
- B. Indoor air handling (fan and coil) units for ductless systems.
- C. Controls.

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment; 2026.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units; 2004.
- C. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units; 2022.
- D. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2027.
- E. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2027.
- F. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical; Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 33 00, for submittal procedures.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Basis of Design: Daikin.

2.02 SYSTEM DESIGN

- A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
 - 1. Heating and Cooling: Air-source electric heat pump located in outdoor unit with evaporator.

2. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Manufacturers:

1. Basis of Design: Daikin.

B. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

1. Location: High-wall.
2. Fan: Line-flow fan direct driven by a single motor.
3. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
4. Wall-Mounted Units:
 - a. Capacity: 2.5-ton

C. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
2. Manufacturer: System manufacturer.

2.04 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Refrigerant: R-410A.
2. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

B. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.

C. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).

1. Provide thermostatic expansion valves.

D. Operating Controls:

1. Control by room thermostat to maintain room temperature setting.

2.05 ACCESSORY EQUIPMENT

- A. Room Thermostat: Wall-mounted, electric solid state microcomputer based room thermostat with remote sensor to maintain temperature setting; low-voltage; with following features:
 1. Automatic switching from heating to cooling.
 2. Preferential rate control to minimize overshoot and deviation from setpoint.
 3. Thermostat Display:
 - a. Actual room temperature.
 - b. System Mode Indication: Heating, Cooling, Fan Auto, Off, and On, Auto or On, Off.

PART 3 - EXECUTION

3.01 INSTALLATION

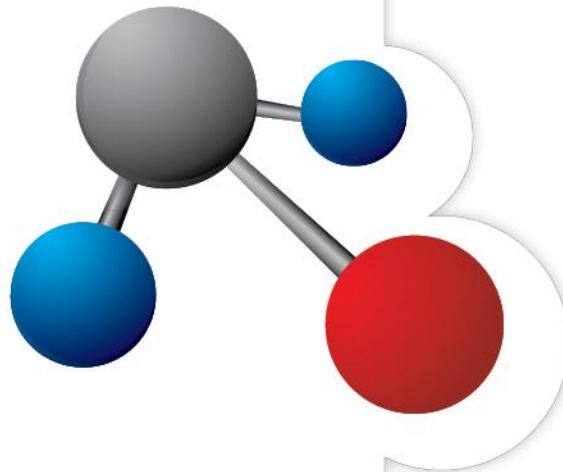
- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION 23 81 26.13

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HILL CITY WWTF IMPROVEMENTS

Volume 2 of 2
Div.26 – Div. 46



PREPARED FOR:

Hill City

Hill City,
South Dakota



HILL CITY

HEART OF THE BLACK HILLS™

AE2S Project No. P12021-2023-005

July 2026

PROJECT MANUAL



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DIVISION 26

ELECTRICAL

SECTION 26 00 00
ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

- A. The Electrical General Requirements outlined in this specification shall apply to Division 26 Electrical Specifications.
- B. The Contractor shall provide supervision, labor, material, equipment, machinery and any other items necessary to complete the electrical systems. Items of equipment are specified in the singular; however, the Contractor shall provide and install the number of items of equipment as indicated in the drawings, and as required for complete systems.

1.02 PERMITS AND FEES

- A. The Contractor shall give necessary notices, obtain permits and pay government and state sales taxes, fees, and other costs, including utility connections or extensions; file necessary plans, prepare documents and obtain necessary approvals of governmental departments having jurisdiction; obtain required certificates of inspection for the work and deliver same to the Engineer before request for acceptance and final payment of the work.

1.03 INTENT

- A. It is the intention of these specifications and drawings to call for finished work, tested, and ready for operation. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready for use."

1.04 SURVEYS AND MEASUREMENTS

- A. The Contractor shall base measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Verify measurements at site and check correctness of same as related to the work.
- B. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the drawings and specifications, they shall notify the Engineer, through the General Contractor, and shall not proceed with the work until they have received instructions from the Engineer.

1.05 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the contract. The engineering drawings and details shall be examined for exact locations of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Engineer.
- B. The Contractor shall follow drawings in laying out work, and check drawings of other trades to verify spaces in which work will be installed.

1.06 "OR EQUAL"

- A. Wherever the words "or equal" or "equal to" or "equivalent" are used in connection with any specified material, it is to be understood that such words mean any material or work of any kind claimed to be an equal in quality to the work or material specified but does not require prior written approval by the Engineer.
- B. Wherever the words "approved equal" or "prior approved equivalent" are used in connection with any specified material, it is to be understood that such words mean any material or work of any kind claimed to be an equal in quality to the work or material specified and shall be so approved in writing by the Engineer.
- C. It is further understood that no material or work shall be presented to the Engineer as work or material equal to that specified with the full understanding on the part of the manufacturers and agents for the so called "equal" material, and the full understanding on the part of the Contractor, that the Engineer is to use his own judgment in the matter, that his decision is final, and that in the event of an adverse condition, no claim of any sort shall be made against the Owner or Engineer.

1.07 SHOP DRAWINGS

- A. The Contractor shall submit for approval, detailed shop drawings of all equipment and material required to complete the project, and no material or equipment may be delivered to the job site or installed until the Contractor has in his possession the approved shop drawings for the material or equipment. The shop drawings shall be completed as described by Specification Section 01 33 00 - Submittal Procedures.

1.08 EQUIPMENT DEVIATIONS

- A. Where the Contractor proposes to use an item of equipment other than that specified or detailed on the drawings, which requires any redesign of the structure, partitions, foundations, piping, wiring, or any other part of the mechanical, electrical, or structural layout; such redesign, new drawings and detailing required therefore shall be prepared by the Contractor at his own expense and approved by the Engineer.

- B. Where such approved deviation requires a different quantity and arrangement of wiring, conduit, and equipment from that specified or indicated on the drawings, the Contractor shall furnish and install any such controllers, motors, starters, electrical wiring and conduit, and any other additional equipment required by the system at no additional cost to the Owner.

1.09 COOPERATION WITH OTHER TRADES

- A. This Contractor shall give full cooperation to other trades and shall furnish in writing to the Contractor, with copies to the Engineer, any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- B. Where the work of the Contractor will be installed in close proximity to, or will interfere with the work of other trades, they shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs their work before coordinating with other trades or so as to cause any interference with work of other trades, they shall make the necessary changes in his work to correct the condition without extra charge.
- C. The Contractor shall furnish to other trades, as required, necessary shop details for the proper installation of work and for the purpose of coordinating adjacent work.
- D. Refer to other Divisions of the Specifications for equipment furnished by others and work required thereof by the Contractor.

1.10 PROTECTION

- A. The Contractor shall protect work and material from damage by their work or workmen and shall be liable for damage thus caused.
- B. The Contractor shall be responsible for work and equipment until finally inspected, tested, and accepted; contractor shall protect work against theft, injury or damage; and shall carefully store material and equipment received on site, which is not immediately installed. Contractor shall close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.

1.11 SCAFFOLDING, RIGGING, HOISTING

- A. The Contractor shall furnish scaffolding, rigging, hoisting, and services necessary for erection and delivery into the premises of any electrical equipment and electrical apparatus furnished. Remove scaffolding, rigging, hoisting, and services from premises when no longer required.

1.12 MATERIAL AND WORKMANSHIP

- A. All materials and apparatus required for the work, except as specifically specified otherwise, shall be new of first-class quality, and shall be furnished, delivered, erected, connected, and finished in every detail, and shall be so selected and arranged as to fit properly into the available spaces. Where no specific kind or quality of material is given, a first-class standard article as approved by the Engineer shall be furnished.
- B. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation or work, together with skilled workmen, helpers, and labor required to unload, transfer, erect, connect, adjust, start, operate, and test each system. The job superintendent shall be a Master Electrician licensed in the State where the work is being performed.
- C. Unless otherwise specifically indicated on the plans or specifications, all equipment and materials shall be installed with the approval of the Engineer in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.

1.13 STANDARDS AND CODES

- A. Provide all material, equipment, and work in accordance with applicable rules, codes, ordinances and regulations of local, state, federal governments, local utility companies, and other authorities having lawful jurisdiction. Conform to the latest editions and supplements of codes, standards, and recommended practices in addition to the following:
 - 1. Safety Codes:
 - a. National Electrical Safety Code Handbook
 - b. Occupational Safety and Health Standard (OSHA)
 - 2. National Fire Codes:
 - a. NFPA 70 - National Electric Code (NEC)
 - 3. Underwriters Laboratories, inc.:
 - a. UL 508A Standard - Industrial Control Panels
 - b. All applicable UL standards as referenced in other sections.
 - c. All material and equipment for the electrical portion of the system shall bear the approval label, or shall be listed by Underwriter's Laboratories, Limited Liability company or another Nationally Recognized Testing Laboratory (NRTL) approved by OSHA and the local electrical inspector.
 - 4. Third Party Certifications:
 - a. All equipment not bearing a UL listing shall be provided with a third-party certification stamped by a registered Professional Engineer licensed in the state of which the work is being performed.
 - 5. State Electrical Board:
 - a. Laws, Rules, Wiring Standards, and applicable local state standards.

- B. Drawings and specifications indicate minimum construction standards. Should any work indicated be substandard to any ordinances, lower codes, rules or regulations bearing on work, the Contractor shall promptly notify the Engineer in writing, through the General Contractor, of any necessary changes to be adjusted. However, if Contractor provides any work knowing it to be contrary to any ordinances, laws, rules and regulations, they shall thereby have assumed full responsibility and bear all costs involved for correction and compliance. In any instance where the specifications call for materials for construction of a better quality or larger size than required by codes, provisions of these specifications shall take precedence. Codes shall govern in case of direct conflict between codes, plans and specifications.

1.14 TESTS AND OPERATION RECORDS

- A. Test all equipment installed and demonstrate its proper operation to the Engineer. No equipment shall be tested or operated for any other purpose, such as checking motor rotation, until it has been fully lubricated in accordance with manufacturer's instructions and, if it is a centrifugal pump, until it has been connected to piping systems and supplied with sufficient water so that it will not run dry.
1. Any defects in workmanship, material, equipment or any grounds or short circuits shall be corrected by the Contractor before final acceptance.
 2. Submit a searchable electronic copy or a minimum of three (3) copies of data noted below to the Engineer prior to final inspection.
 3. Maintain a marked set of drawings to record all deviations made from routes, locations, circuiting, etc. shown on contract drawings. Prior to final inspection submit one new set of project drawings with deviations and changes clearly indicated.
- B. The entire electrical system shall be tested by Contractor in presence of the Engineer. Every local switch, panelboard, service breaker, safety switch, and circuit breaker shall be operated under load conditions. Every fixture and equipment tested and operated. Tests shall include any tests specified in any part of this section.
1. The Contractor shall measure resistance of electrical system with a "Megger" from busses of main switch to ground with main breaker open, and bonding jumper between neutral and ground temporarily removed. Values are to be determined with all panelboards, motor controls and switch circuits open. If any value measured is less than 100,000 ohms, each feeder shall be measured and must exceed those set forth in Article 110 of National Electrical Code, before they shall be accepted. Typewritten test results shall be furnished to the Engineer.
- C. Recording and Distribution

1. Record nameplate horsepower, amperes, volts, phase, efficiency, service factor and other necessary data on motors, and other electrical equipment furnished and/or connected under this contract.
2. Record motor starter catalog number, size and rating and/or catalog number of thermal overload units installed in all motor starters furnished and/or connected under this contract. See motor starter specifications for instructions for proper sizing of thermal overload units.
3. Record ampere per phase at normal or near normal loading of each item of equipment furnished and/or connected.
4. Record voltage and ampere per phase readings taken at service entrance equipment after completion of project with operation at normal electrical load.
5. Record all VFD settings, solid-state motor controller settings, electronic overload relay settings, relay settings, device settings, and related electronic equipment settings.
6. Record all instrumentation and device calibration settings.
7. Distribute copies of recorded information to the Engineer along with the project O&M manuals.

1.15 DEMONSTRATION OF COMPLETED ELECTRICAL SYSTEMS

- A. General: Upon completion of entire electrical systems, Contractor shall demonstrate to Engineer's satisfaction that all installed electrical systems are in perfect operating condition, that they perform all power and control functions intended and that they are installed in strict accordance with project drawings and specifications.
- B. Materials: Contractor shall provide necessary testing equipment, tools, materials, dummy loads, etc., required to properly demonstrate performance.

1.16 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall submit O&M manuals for approval of all equipment and material required to complete the project per Specification Section 01 78 23 - Operation and Maintenance Data .

END OF SECTION 26 00 00

SECTION 26 05 02
EXCAVATING, TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide trenching/backfill/compaction/surface restoration required to install

1.02 QUALITY ASSURANCE

- A. Engineer may have compaction tests taken by an independent testing laboratory. Cost will be paid by Owner unless tests indicate compaction does not meet Specifications in which case costs of initial test and any retesting will be paid by the Contractor and not charged to the Owner.
- B. Properly protect existing surfaces and items not included in this work and repair any damage to original condition.
- C. Take precautions to guard against movement, settlement, collapse, or other damage of existing construction and finish grade and repair any damage to original condition.
- D. Perform construction stakes, lines, and grades under direct supervision of a Registered Land Surveyor or Registered Civil Engineer.

1.03 EXISTING CONDITIONS

- A. Determine exact locations of existing utilities before commencing work. Contractor is responsible for damages incurred by his failure to locate and preserve underground utilities. It is Contractor's responsibility to contact "One Call Locators" prior to performing any excavation.

PART 2 - PRODUCTS

2.01 GENERAL BACKFILL REQUIREMENTS

- A. Special Fill Gravel (Inside Building Line):
 - 1. Washed type with 100% passing 3/4" sieve and gradation to ensure compactibility with no more than 5% passing No. 200 sieve.
- B. Outside Building Line: Native backfill.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Clear trenching work area.

- B. Excavate to depths as indicated on drawings or as required by NEC, whichever is greater.
- C. Provide electrical ribbon marker tape above conduits in each trench.
- D. Notify Engineer immediately if during progress of work, subsurface conditions are encountered which are different from those ordinarily anticipated.
- E. Excavated material, free from foreign material, may be used for backfilling outside building and rough grading. Remove any excess from site.
- F. Fill excavation below required depth with compacted special fill gravel as per section 2.01.
- G. Protect bottom of excavation from frost and do not place structures or conduit on frozen ground.
- H. FILL WITHIN BUILDING (Under Concrete Slabs on Grade):
 - 1. Place and compact fill in successive layers not to exceed eight (8) inches before compaction. Compact to minimum of 95% per ASTM D698.
- I. Nonorganic material from building excavating may be used for fill within building.
- J. Place a six-inch layer of special fill gravel per spec section 2.01 immediately below the floor slab.
- K. BACKFILL OUTSIDE BUILDING:
 - 1. Do not start backfilling until the work which will be covered is completed and areas are free of foreign material.
 - 2. Place and compact fill in successive layers not to exceed eight (8) inches before compaction. Compact to minimum of 95% per ASTM D698.
- L. Nonorganic material excavated from foundation areas may be used as backfill in exterior areas.

3.02 ROUGH GRADING

- A. Clean areas of foreign material. Using stockpile excavation materials or off site material of equal quality, bring grades to within 6 inches of finish grade elevations.

3.03 FINISH GRADING

- A. Using stockpile topsoil from stripping or off site topsoil of equal quality finish grade areas within construction limits to given minimum of 6 inches material depth. Bring to elevations indicated on Drawings or existing elevations.

3.04 BLACK DIRT

- A. Place 6 inches under lawns.
- B. Restore surface to original condition.

END OF SECTION 26 05 02

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SECTION 26 05 05
SELECTIVE DEMOLITION FOR ELECTRICAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
 - 1. Electrical demolition.

1.02 SUBMITTALS

- A. Certification of removal and appropriate disposal of abandoned cables containing lead stabilizers.
- B. See Section 01 33 00 - Submittal Procedures for submittal procedures.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. As specified in individual sections.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify field measurements and circuiting arrangements are as indicated.
- B. Verify that abandoned wiring and equipment serve only abandoned facilities.
- C. Demolition drawings are based on casual field observation and existing record documents.
- D. Report discrepancies to Engineer before disturbing existing installation.
- E. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION

- A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
- B. Coordinate utility service outages with utility company.
- C. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.

1. Obtain permission from Owner at least 48 hours before partially or completely disabling system.

3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Perform work for removal and disposal of equipment and materials containing toxic substances regulated under the Federal Toxic Substances Control Act (TSCA) in accordance with applicable federal, state, and local regulations. Applicable equipment and materials include, but are not limited to:
 1. PCB-containing electrical equipment, including transformers, capacitors, and switches.
 2. PCB and DEHP-containing lighting ballasts.
 3. Mercury-containing lamps and tubes, including fluorescent lamps, high intensity discharge (HID), arc lamps, ultra-violet, high pressure sodium, mercury vapor, ignitron tubes, neon, and incandescent.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring to source of supply.
- D. Disconnect and remove abandoned panelboards and distribution equipment.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
- G. Repair adjacent construction and finishes damaged during demolition and extension work.
- H. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or that are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

- C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.

END OF SECTION 26 05 05

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SECTION 26 05 08
ELECTRICAL SERVICE

PART 1 - GENERAL

1.01 SUMMARY

- A. Existing electrical service will be disconnected and removed. Coordinate work and schedule with serving electric utility and Owner.
- B. Black Hills Energy will provide a new 277/480V, 3PH, 4W Service.
- C. Associated Charges:
 - 1. All charges payable to Black Hills Energy shall be paid by the Owner outside of this Contract.

1.02 QUALITY ASSURANCE

- A. NFPA 70 - National Electrical Code.

1.03 EXISTING CONDITIONS

- A. Contact the Utility Company for verification of the exact connection point for each service required.

PART 2 - EXECUTION

2.01 INSTALLATION

- A. Verify requirements and installation locations with Utility Company before installation.
- B. Terminate rigid metallic service conduit (if used) in transition cabinet, meter socket, and combination main switch/automatic transfer switch with grounding bushing.
- C. Make ground connection from bushing to ground bus.
- D. The serving electric Utility Company is:
 - 1. Black Hills Energy
 - a. Attn: Tara Bland
 - b. Phone: (605)440-7205
 - c. Email: Tara.Bland@blackhillscorp.com
- E. All work will be coordinated with Utility and Owner and scheduled for minimum of service interruption.
- F. Summary of existing Site Electrical Service Demolition

1. Existing utility transformer to be disconnected and removed from existing fiberglass pad by serving electric utility.
2. Existing fiberglass pad to remain for use by serving electric utility for switching module. See 'SW' series Drawings for details.
3. Existing secondary conductors and conduit to remain for reuse from transformer to existing MCC-100. EC to prep area to cut back conduit as required for new connection cabinet installation.

G. Summary of Site Electrical Service Installation:

1. New utility transformer fiberglass pad provided by EC in location shown on Drawings.
2. New utility transformer to be provided by serving electric utility.
3. (6) 2" PVC conduits stubbed from primary section of transformer pad provided by EC for use by Utility Company for primary cables.
4. Primary underground conductors to transformer by serving electric utility.
5. Primary and secondary terminations within transformer by electric utility company.
6. Connection cabinet and connection cabinet fiberglass pad furnished and installed by EC per serving utility requirements.
7. Conductors and conduit between transformer and connection cabinet provided by EC per serving utility requirements.
8. Meter shall be furnished by serving electric utility and installed on a contractor furnished meter socket by the EC on connection cabinet. Coordinate exact metering/meter socket requirements and required clearances with serving electric utility company.
9. 1-1/4" conduit from transformer secondary to meter stand by EC per serving utility standards.
10. Metering shall be Current Transformer (CT) type. CT's will be furnished and installed by electric utility company on the transformer secondary.
11. CT's, CT wiring and associated CT wiring terminations furnished and installed by serving electric utility.
12. Secondary Service Lateral conduit per Drawings from transformer secondary compartment underground to line side of the ATS by EC (See the Drawings for circuitry requirements). Secondary conductors provided and installed by the EC in the EC furnished underground conduits. Terminations at the transformer by serving electric utility. Terminations at the ATS by the EC.
13. Secondary underground electrical service shall be provided by the Contractor and installed from the transition cabinet to the main service automatic transfer switch within 'EB' building. Terminations shall be by Contractor.

H. Proposed Utility Phasing Plan

1. Existing service to remain in use until new addition is fully energized and existing building feeder circuits are ready for switchover.
2. Both the existing and new transformers could be energized simultaneously for a short period of time. Temporary power connections are not anticipated for switchover to new utility service. If temporary power is required for any reason, EC to submit temporary power connection plan for Engineer approval.
3. New utility transformer and related service equipment to installed as noted above and within Drawings prior to disconnection of existing service.
4. New transformer to be energized and new plant additions to be fully operational prior to disconnection and removal of existing transformer.
5. EC to install new connection cabinet (PB-CC1) on new pad in location of removed transformer and extend feeder circuitry from 'EB' building to primary side of new connection cabinet.
6. EC to install feeders from new 'EB' building to new connection cabinet (PB-CC1). EC to cut back and extend existing conduit from removed transformer sleeve to new connection cabinet location.
7. Once the new additions are fully operational, EC to coordinate with serving electric utility and Owner for disconnection of existing service and connection of existing 'PB' building to new 'EB' building.

END OF SECTION 26 05 08

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SECTION 26 05 10
MOTORS

PART 1 - GENERAL

1.01 REFERENCES

- A. Anti-Friction Bearing Manufacturers Association (AFBMA)
 - 1. Load Ratings and Fatigue Life for Ball Bearings
- B. Institute of Electrical and Electronic Engineers (IEEE)
 - 1. IEEE 112 Standard Test Procedure for Polyphase Induction Motors and Generators
- C. National Fire Protection Association (NFPA):
 - 1. NFPA 70 - National Electrical Code (NEC), Current Adopted Edition.
- D. National Electrical Manufacturer's Association (NEMA).
 - 1. NEMA MG 00001 - Motors and Generators.
 - 2. NEMA EN 10250 - Enclosures for Electrical Equipment.

1.02 DELIVERY, STORAGE AND HANDLING

- A. Motors shall be covered and stored in a dry, warm (50°F) location prior to installation.
- B. Once installed, the space shall be heated and kept dry. The motor shall be covered until ready for service. Covering shall not trap moisture in the motor.

1.03 SUBMITTALS

- 1. Equipment mechanical and electrical specification sheets
- 2. Efficiency information

1.04 OPERATION AND MAINTENANCE DATA

PART 2 - PRODUCTS

2.01 MOTORS

- A. Motors shall conform with applicable NEMA, IEEE, and ANSI standards. Motors using non-standard frames or otherwise of special characteristics will be permitted only by special permission of the Engineer, the intent being to confine such usage to cases of absolute necessity.

- B. Motor ratings shall be based on current NEMA design standards for continuous duty and/or multiple starts per hour on motors through 100 horsepower. On motors larger than 100 horsepower starting shall be based on NEMA MG1-20.43 number of starts. Horsepower, torque, and speed characteristics shall be suitable for the full normal range of operating conditions of the driven equipment without exceeding 95% of the nameplate FLA and the temperature rise ratings regardless of size. Nameplate FLA shall be based on nameplate HP and shall not include the 15% S.F. In addition, all motors 1 horsepower and larger shall have a 1.15 service factor. Wherever horsepower ratings of motors proposed differ from those shown or specified, this fact shall be prominently noted on the shop drawings submitted, or otherwise brought to the attention of the Engineer.
- C. Process and major equipment drive motors shall be 3 phase, squirrel-cage induction type NEMA Design B, dual voltage in all sizes and types where this rating is standard. Larger motors and special motors where dual voltage construction is not available shall be furnished in ratings consistent with the nominal system voltage. Where process drives of fractional horsepower are required, standard frame 56 units shall be supplied. Such drives requiring limited power input shall employ overload heaters undersized accordingly.
- D. General purpose single phase motors, 1/3 HP and smaller, shall be 115 volt capacitor start type designed for continuous duty. Light duty motors of the domestic appliance variety will not be acceptable in this work. Bearings on frame 56 fractional horsepower motors shall be of the antifriction or sleeve type.
- E. The Division furnishing motors, or equipment containing or including motors, shall be responsible for delivery, handling and setting regardless of local agreements as to actual work jurisdiction. Further, this responsibility shall include checking of lubrication, drive alignment and condition, indication of proper rotation, and any or all other matters relating to operative readiness. When all checks are satisfactorily accomplished, the readiness of the unit for operation shall be indicated by a conspicuous and legible tag installed by the responsible individual.
- F. As part of the operational test the responsible Division shall arrange for checking and recording of load current and verification of rating of overload heaters. No unattended operation of the equipment shall be permitted until completion of this procedure.
- G. Motor frames shall be totally enclosed fan cooled (TEFC) unless otherwise specified.
- H. All motors larger than NEMA 56 frame shall have antifriction (ball or roller) bearings, sized for a B10 life of at least 30,000 hours under normal loading conditions. Bearing shall be AFBMA standard sizes. Motors shall be equipped with end shield mounted ball bearings made to AFBMA standards and be of

ample capacity for the motor rating. The bearing housing shall be large enough to hold sufficient lubricant to minimize the need for frequent relubrication, but facilities shall be provided for adding new grease and draining out old grease without major motor disassembly. The bearing housing shall have long, tight, running fits or rotating seals to protect against the entrance of foreign matter into the bearings, or leakage of grease out of the bearing cavity.

I. Balance and Vibration:

VIBRATION LIMITS:

Maximum Permissible Total Amplitude Peak to Peak (in.)

Frame Diameter Series	Below 1700 RPM	1700 - 3499 RPM	3500 & above RPM
180,210,220	0.002	0.0015	0.001
250,280,320	0.002	0.0015	0.001
360,400,440	0.002	0.0015	0.001

1. If balancing weights are added to the rotor, they shall be permanently secured by welding, peening, or other method approved by the Engineer.

J. Materials:

1. Stator Frames and Endshields as follows:
 - a. Dripproof and Standard Duty – TEFC: Stator frames and endshields, may be cast aluminum, steel, or cast iron, whichever is manufacturer's standard.
2. Other External Parts as Follows:
 - a. Dripproof and Standard Duty - TEFC: Fan covers and conduit boxes may be cast iron, aluminum or steel, depending on manufacturer's standard.
 - b. Severe Duty - TEFC and Explosion Proof: Fan covers and conduit boxes shall be cast iron.

K. Conduit Boxes:

1. For motors with parallel sets of cables or other field circumstances which require it, Contractor shall provide a new terminal box which meets the size requirements of the NEC.

L. Eyebolts:

1. All motors weighing more than 50 lbs. shall be drilled and tapped for a lifting eyebolt.

M. Motor Leads:

1. Motor leads into conduit box shall have same insulation class as the winding and be equipped with a numbered brass or copper terminal

staked or otherwise mechanically fastened to the lead sufficient to resist 15 lbs. pull. Leads shall be marked throughout the entire length to provide identification after terminals are taped or clipped.

N. Ventilating Fans:

1. Dripproof and TEFC: The fans forcing ventilating air through or over a motor may be steel, aluminum, or molded plastic, whichever is manufacturer's standard.
2. Severe Duty - TEFC and Explosion Proof: Ventilating fans shall be non-sparking, abrasion and chemical resistant, cast brass or polypropylene.

O. Shaft Seals:

1. All severe duty motors and TEFC motors, 254 frame and larger, shall have a rotating seal or slinger located on the shaft at the drive end endshield opening to prevent moisture or other foreign material from entering the bearing cavity.

P. Nameplates:

1. Aluminum nameplates may be used on drip-proof and standard TEFC motors. Severe duty enclosed motors shall have nameplates of stainless steel. Nameplates shall be stamped to include the following information:
 - a. Horsepower (not including 15% S.F.)
 - b. Speed
 - c. Time Rating
 - d. Frequency
 - e. Phases
 - f. Model Number
 - g. Rated Voltage
 - h. Full Load Amps (based on nameplate HP, not including 15% S.F.)
 - i. Insulation Class
 - j. NEMA Design
 - k. NEMA Code Letter
 - l. Maximum Ambient
 - m. Bearing Identification
 - n. Power Factor

Q. Connection Diagrams

1. The motor connection diagram shall be permanently attached to the motor either inside the conduit box or on the motor frame in a readable location from the conduit box side.

R. Locked Rotor Characteristics:

1. Unless shown otherwise, motors with a nameplate rating of 5 to 20 horsepower shall have a locked rotor characteristic not exceeding Code

H. Motors with a nameplate rating of 25 through 50 horsepower shall not exceed NEMA Code G locked rotor characteristics. Motors larger than 50 horsepower shall not exceed NEMA Code F locked rotor characteristics.

S. Severe Duty:

1. Motors designated for severe duty shall have the following characteristics in addition to those designated in the specification:
 - a. Stainless steel nameplate.
 - b. Cast iron housing, bearing brackets, fan guard.
 - c. Cast iron conduit box.
 - d. Cast brass or polypropylene fan.
 - e. Zinc plated hardware.
 - f. Minimum of 2 extra epoxy varnish, or equal, dips and bakes on windings.

T. Inverter Duty (VFD Applications):

1. Motors designated for inverter duty shall meet standard NEMA MG1 Part 31 in addition to the following characteristics:
 - a. Specifically designed for use with a solid-state inverter variable frequency drive (VFD).
 - b. Minimum service factor of 1.00 when operating from a VFD.
 - c. 1600V insulation system designed for inverter duty, Class F temperature rise minimum.
 - d. Insulated or insulated/ceramic bearing on the non-drive end of the motor to complement the bearing protection (shaft grounding) ring (installed on the drive end of the motor) in eliminating circulating currents for NEMA and IEC motors [75]hp and larger. Specialty, non NEMA motors, such as those used in submersible type applications, do not require the installation of the bearing protection ring on the drive end of the motor or the insulated or insulated/ceramic bearing on the non-drive end of the motor.
 - e. Thermal switch embedded in the motor windings to stop the VFD on motor overtemperature condition. Normally closed contacts rated 5A at 120 VAC, nominal.
 - f. Include appropriately sized Aegis™ SGR bearing protection ring on all NEMA and IEC motors 75 hp or larger to eliminate circulating currents that could potentially damage the motor bearings. Coat motor shaft with Aegis™ “Colloidal Silver Shaft Coating” product, Part No. CS015 prior to the installation of the bearing protection ring. Confirm and coordinate the type of protection ring mounting (conductive epoxy, standard, split ring, bolt-thru, press-fit, etc.) best suited for the shaft/motor installation being furnished.
 - g. Motor horsepower full load amps shall not exceed NEC table 430-250.
 - h. Include RTDs on all motors larger than 250HP as specified later in this section.

U. Heater:

1. Where specified in the process equipment section, motors shall contain internal heaters to operate on 120 VAC to minimize condensation inside the motors. Unless otherwise required, the nominal heater size shall be 150 VA minimum.

V. External Finish:

1. All motors shall be prime painted with corrosion resisting metal primer, and finish painted with a durable machinery gray enamel, manufacturer's standard unless otherwise specified.
2. All bolts, screws, and other external hardware shall be treated by zinc with iridite or zinc chromate for resistance to corrosion.

W. Testing:

1. Motor testing procedure shall be in accordance with the American Standard Test Code for polyphase induction motors and generators, IEEE 112A. All motors shall be given routine test to determine that they are free from electrical or mechanical defects. The routine test shall, as a minimum, conform to MG1-12.55.

X. Preparation for Shipment:

1. Before shipment, the shaft extension and any other bare exposed metal parts of each motor shall be coated with an easily removable rust preventative.
2. All motors shall be securely fastened to a hardwood skid or pallet for fork truck handling and be covered for protection against dirt and moisture during transit and for short time outdoor storage.

Y. Operating Characteristics:

1. Motors shall meet or exceed the starting locked rotor and maximum breakdown torques specified by NEMA for the NEMA design. The locked rotor starting currents shall not exceed NEMA maximum values for the specified NEMA design and rating. The current density and heating characteristics shall be such that the motors will not suffer damage if subjected to a maximum of ten (10) seconds stall at six times full load current. Except as noted, the services factor of the motor shall be in accordance with NEMA Standards. The insulation system of the motor shall be designed for 40,000 hours operation under usual service conditions as described under NEMA MG1-14.2. The motor manufacturer shall use IEEE standards to establish the suitability of the insulation system to meet these requirements.

Z. Energy Efficiency:

1. Efficiency shall be defined as the “NEMA Nominal Efficiency” at full load, as detailed in NEMA MG-1-12.58 and shall meet or exceed the values in the following tables. If a higher value is specified in the respective equipment section, then the higher value shall apply.
2. Efficiency shall be defined as the “NEMA Nominal Efficiency” at full load, as detailed in NEMA MG-1-12.58 and shall meet or exceed the values in the following tables. If a higher value is specified in the respective equipment section, then the higher value shall apply.

Full Load Efficiencies of Premium Efficient Motors

OPEN MOTORS			HP	CLOSED MOTORS		
1200 RPM	1800 RPM	3600 RPM		1200 RPM	1800 RPM	3600 RPM
82.5	85.5	77.0	1.0	82.5	85.5	77.0
86.5	86.5	84.0	1.5	87.5	86.5	84.0
87.5	86.5	85.5	2.0	88.5	86.5	85.5
88.5	89.5	85.5	3.0	89.5	89.5	86.5
89.5	89.5	86.5	5.0	89.5	89.5	88.5
90.2	91.0	88.5	7.5	91.0	91.7	89.5
91.7	91.7	89.5	10.0	91.0	91.7	90.2
91.7	93.0	90.2	15.0	91.7	92.4	91.0
92.4	93.0	91.0	20.0	91.7	93.0	91.0
93.0	93.6	91.7	25.0	93.0	93.6	91.7
93.6	94.1	91.7	30.0	93.0	93.6	91.7
94.1	94.1	92.4	40.0	94.1	94.1	92.4
94.1	94.5	93.0	50.0	94.1	94.5	93.0
94.5	95.0	93.6	60.0	94.5	95.0	93.6
94.5	95.0	93.6	75.0	94.5	95.4	93.6
95.0	95.4	93.6	100.0	95.0	95.4	94.1
95.0	95.4	94.1	125.0	95.0	95.4	95.0
95.4	95.4	94.1	150.0	95.8	95.8	95.0
95.4	95.8	95.0	200.0	95.8	96.2	95.4
95.4	95.8	95.0	250.0	95.8	96.2	95.8
95.4	95.8	95.4	300.0	95.8	96.2	95.8
95.4	95.8	95.4	350.0	95.8	96.2	95.8
95.8	95.8	95.8	400.0	95.8	96.2	95.8
96.2	96.2	95.8	450.0	95.8	96.2	95.8
96.2	96.2	95.8	500.0	95.8	96.2	95.8

2.02 HAZARDOUS AREA CLASSIFICATION REQUIREMENTS

- A. The requirements stated in this section are to be in addition to those described above for areas noted in hazardous area classifications on engineer's drawings.
- B. Motors installed within Class 1 Division 1 Group D environment(s):
 - 1. Motors shall be of the non-arcing squirrel-cage induction or totally enclosed submersible type and clearly identified as suitable for use in a Class 1 Division 1 Group D rated environment unless otherwise stated in drawings.
- C. Motors Installed within Class 1 Division 2 Group D environment(s):
 - 1. Motors that are of the non-arcing squirrel-cage induction or totally enclosed submersible type shall have permanent marking on motor nameplate indicating equipment is suitable for use in a Class 1 Division 2 Group D environment or indication of maximum operating temperature of exposed surfaces do not exceed 80 percent of the autoignition temperature of the gas or vapor present in the installed environment.
 - 2. Motors with potentially arcing components shall be rated for Class 1 Division 1 Group D.
 - 3. Motors requiring space heaters installed within windings for condensation prevention shall be rated for Class 1 Division 2 Group D environment or have a visible label indicating the operating temperature of heater does not exceed 80 percent of ignition temperature of gasses present in the installed environment.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All wire terminations within the motor termination j-box for 480V class motors and below shall be performed by means of utilizing insulated connector blocks in lieu of wire nuts or split bolt connectors and mastic tape. The insulated connector blocks shall be manufactured by Polaris, IlSCO, or equal.

3.02 SUBMITTAL DATA SHEETS

- A. Contractor shall fill out and submit attached "Motor Data Sheet" for each project motor as part of shop drawings submittals. Contractor shall copy the attached Motor Data Sheet as required for submitting on all project motors. See Motor Data Sheet located at the end of this Section.
- B. Contractor shall fill out and submit the attached "Pump/ Equipment Control Data Sheet" for each project motor driven equipment item as part of the shop drawing submittals. Contractor shall copy the attached Pump/ Equipment Control Data

Sheet as required for submittals for all project motor driven equipment. See Pump/ Equipment Control Data Sheet located at the end of this Section.

3.03 START UP

- A. Arrange for checking and recording of load current and verification of rating of overload heaters. No unattended operation of equipment shall be permitted until completion of this procedure.
- B. Arrange for checking and recording of load current and verification of rating of overload heaters. No unattended operation of equipment shall be permitted until completion of this procedure.

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MOTOR DATA SHEET

JOB NO. _____ CONTRACT NO. _____
TAG NO. _____ DESCRIPTION _____

NAMEPLATE DATA

MFG _____ TYPE _____ FRAME _____
HP _____ DESIGN _____ PHASE _____
VOLTS _____ AMPS _____ INS. CLASS _____ DESIGN RISE (C) _____
NEMA CODE LETTER _____ POWER FACTOR _____ MAX AMBIENT (C) _____
ENCLOSURE TYPE _____ S.F. ON A-T-L START _____ S.F. ON VFD _____
WEIGHT (LBS) _____ LUBRICATION TYPE _____
INVERTER DUTY (Y/N) _____ INSULATED BEARING ON NON DRIVE END (Y/N) _____
TYPE/ MATERIAL OF BEARINGS (DRIVE END) _____
TYPE/MATERIAL OF BEARINGS (NON DRIVE END) _____

PERFORMANCE DATA

NEMA NOMINAL EFFICIENCY AT FULL LOAD (%) _____
GUARANTEED EFFICIENCY AT FULL LOAD (%) _____ $\frac{3}{4}$ LOAD _____ $\frac{1}{2}$ LOAD _____
POWER FACTOR AT FULL LOAD (%) _____ $\frac{3}{4}$ LOAD _____ $\frac{1}{2}$ LOAD _____
NO LOAD AMPS _____ MAX KVAR _____

THERMAL DATA ROTOR INERTIA

(LB-FT SQ.) _____ LOAD INERTIA (LB-FT SQ.) _____ LOCKED ROTOR
AMPERES: AT MAXIMUM RATED TERMINAL VOLTAGE (100%) _____ AT
SPECIFIED TERMINAL VOLTAGE (____%) _____ AT MINIMUM
RATED TERMINAL VOLTAGE (____%) _____ ACCELERATION TIME
(SECONDS) OF MOTOR PLUS LOAD: AT MAXIMUM RATED TERMINAL VOLTAGE
(100%) _____ AT SPECIFIED TERMINAL VOLTAGE
(____%) _____ AT MINIMUM RATED TERMINAL VOLTAGE
(____%) _____ SAFE STALL TIME (SECONDS): AMBIENT _____
RUNNING _____ MAXIMUM STARTS PER HOUR _____

ACCESSORY DATA THERMAL SWITCHES

(Y/N) _____ TYPE/ MFR/ MODEL _____ TRIP TEMP (C) _____ STATOR RTDS:
TYPE _____ OHMS _____ QUANTITY _____ TRIP/ALARM TEMP (C) _____ BEARING RTDS:
TYPE _____ OHMS _____ QUANTITY _____ TRIP/ALARM TEMP (C) _____

JOB NO. _____ CONTRACT
NO. _____ TAG
NO. _____ DESCRIPTION _____

NAMEPLATE DATA AND STARTING METHOD PUMP OR EQUIPMENT

MFG _____ TYPE/ MODEL _____ BRAKE HORSEPOWER
REQUIREMENT OF DRIVEN LOAD BASED ON DESIGN CRITERIA
(HP) _____ MOTOR MFG _____ TYPE/
MODEL _____ HP _____ RPM _____
DESIGN _____ PHASE _____ VOLTS _____ AMPS _____
MAXIMUM AMBIENT OPERATING TEMP (C) _____ TYPE OF MOTOR STARTING
METHOD DESIGNED AROUND: A-T-L START, ELECTRONIC SOFT START, VFD
START (CIRCLE ONE). SUITABLE FOR USE ON A-T-L STARTING METHOD
(Y/N) _____ SUITABLE FOR USE ON ELECTRONIC SOFT
STARTING METHOD (Y/N) _____ SUITABLE FOR USE ON VFD STARTING
METHOD (Y/N) _____ MOTOR OVERLOAD PROTECTION
CLASS REQUIRED (CLASS 10, CLASS 20, CLASS 30) – CIRCLE ONE

CONTROL REQUIREMENTS MINIMUM START UP VOLTAGE

(%) X RATED VOLTAGE _____ MINIMUM START UP CURRENT
(%) X FULL LOAD AMPS _____ MAXIMUM RAMP UP TIME
FROM STOPPED CONDITION TO MINIMUM SPEED (SEC) _____ MIN
OPERATING SPEED (RPM) _____ MAX OPERATING SPEED (RPM) _____ MIN
OPERATING SPEED (HZ) _____ MAX OPERATING SPEED (HZ) _____
MINIMUM FLOW (FPS) _____ MINIMUM FLOW (GPM) _____ IS
A DUAL SLOPE RAMP ON START UP REQUIRED? (Y/N) _____ IF
A SINGLE SLOPE OR DUAL SLOPE RAMP ON START UP IS BEING PROVIDED,
WHAT IS THE MAXIMUM ALLOWABLE RAMP TIME FOR ATTAINING MINIMUM
SPEED FROM A STOPPED CONDITION (SEC) _____ MAXIMUM RAMP DOWN TIME
FROM MINIMUM RUNNING SPEED TO STOPPED (SEC) _____ IS THERE A REED
CRITICAL FREQUENCY OR SKIP FREQUENCY THAT SHOULD BE AVOIDED?
(Y/N) _____ IF THERE IS A FREQUENCY OR FREQUENCY BAND THAT
SHOULD BE AVOIDED FOR MOTOR OPERATION, WHAT IS
IT ?(HZ) _____ IF OPERATION IS FROM A VFD, WHAT METHOD OF
VFD CONTROL IS SUGGESTED OR PREFERRED (VOLTS/HERTZ, SENSOR-LESS
VECTOR, OTHER?) PLEASE FILL IN _____

END OF SECTION 26 05 10

SECTION 26 05 19
POWER AND INSTRUMENTATION CABLE - LESS THAN 600V

PART 1 - GENERAL

1.01 REFERENCE STANDARDS:

- A. UL 486A-486B - Wire connectors
- B. NEMA WC 70
- C. NEMA WC30-1976
- D. NFPA 70 - National Electrical Code, current adopted Edition.
- E. NFPA 79 - Electrical Standard for Industrial Machinery.

1.02 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver conductors to project on standard coils or reels and suitably protected from weather and damage during storage and handling.

1.03 APPROVAL DRAWINGS

- A. Provide Shop Drawings on all products identified herein.

PART 2 - PRODUCTS

2.01 CONDUCTORS

- A. Type P1 - 600V Rated General Purpose Single Conductor Cable
 - 1. Construction:
 - a. #14 AWG and larger: Stranded Copper, (THHN/THWN-2). Solid Copper is acceptable for lighting and branch circuits.
 - b. Conductors shall contain factory color coded insulation in standard colors to match the voltage level used.
 - c. Sequential footage markers shall be factory installed on the insulation jacket.
 - d. Aluminum conductors are not permitted.
 - 2. Feeder Conductors:
 - a. 98 percent conductivity copper, 600-volt insulation.
 - 3. Branch Circuit Conductors:
 - a. 98 percent conductivity copper, 600-volt insulation.
 - b. Conductors smaller than No. 14 AWG are not permitted except in control panel.
 - 4. Project Use Areas:
 - a. General use indoor building circuiting.
 - b. Not allowed for VFD output circuitry.
 - 5. Manufacturer:

- a. Service Wire Co.
- b. Okonite Co.
- c. Southwire
- d. Belden
- e. Alpha Wire

B. Type P2 - 600V Rated Special Purpose Single Conductor Cable

- 1. Construction:
 - a. XHHW-2 insulation which is moisture, heat, and flame-retardant cross-linked polyethylene covered with an overall flame retardant, moisture and sunlight resistant PVC jacket.
 - b. Stranded Copper
 - c. Conductors shall contain factory color coded insulation in standard colors to match the voltage level used.
 - d. Sequential footage markers shall be factory installed on the insulation jacket.
 - e. Aluminum conductors are not permitted.
- 2. Project Use Areas:
 - a. 600V and less service entrance conductors and feeders routed underground from the exterior to the interior.
- 3. Manufacturer:
 - a. Service Wire Co.
 - b. Okonite Co.
 - c. Southwire
 - d. Belden
 - e. Alpha Wire

C. Type P4 - Multiconductor Shielded VFD Cable

- 1. Sizes: #16 AWG through #2 AWG.
 - a. Construction:
 - 1) Three stranded, Class D, tin plated copper conductors with XLPE (crosslinked polyethylene) insulation.
 - 2) Overall shield + 85% TC braid plus full-size TC drain wire.
 - 3) Black sunlight-and oil-resistant PVC jacket.
 - 4) One full-sized insulated ground conductor.
 - 5) Cable construction for direct-buried applications shall include interlocked, corrugated aluminum armor protection.
 - b. Ratings/Listings:
 - 1) 1000V UL Flexible Motor Supply.
 - 2) 600V UL 1277 Type TC-ER per the NEC.
 - 3) 1000V UL 2277 Type WTTC.

- 4) IEEE 1202/383
 - 5) UL Direct Burial
 - 6) 90 deg C Wet/Dry
 - 7) UL 1685 Vertical Tray Flame Test
 - 8) CE approved.
2. Sizes #1 AWG through #4/0 AWG.
- a. Construction:
 - 1) Three stranded, Class D, tin plated copper conductors with XLPE (crosslinked polyethylene) insulation.
 - 2) Two spiral copper tape shields with 100% coverage.
 - 3) Black sunlight-and oil-resistant PVC jacket.
 - 4) Three symmetrical bare copper grounds.
 - 5) Cable construction for direct buried applications shall include interlocked, corrugated aluminum armor protection.
 - b. Ratings/Listings:
 - 1) 1000V UL Flexible Motor Supply
 - 2) 600V UL 1277 Type TC-ER per the NEC.
 - 3) 1000V UL 2277 Type WTTTC
 - 4) IEEE 1202/383
 - 5) UL Direct Burial
 - 6) 90°C (194°F) Wet/Dry
 - 7) UL 1685 Vertical Tray Flame Test
 - 8) CE approved.
3. Project Use Areas:
- a. Motor branch circuit conductors for all VFD driven motors from the VFD to the motor.
 - b. Cables which pass through Hazardous Areas shall be rated for the environment and installed to meet all Article 500 NEC requirements.
4. Manufacturer:
- a. Belden Series 29500
 - b. Service Wire Co. Equal
 - c. Okonite Co. Equal

- d. Southwire Equal
- e. Alpha Wire Equal

D. Type S1 - Signal Cable - Single Pair - Shielded/Twisted

1. Construction
 - a. Type CMP Single pair, twisted, 100% shield coverage, Class B, #16 AWG, stranded (19 x 29) tinned copper conductors (7 strand minimum).
 - b. 600V minimum insulation rating.
 - c. 15 mil (nominal), 90°C (194°F) PVC primary insulation with a flame retardant, low smoke PVC, plenum rated.
 - d. Conductors shall be shielded with a 0.35 x 5 mil (min.), 100% coverage, aluminum or copper mylar tape shield, or equal with an 18-gauge strand copper drain wire.
2. Ratings/Listings:
 - a. Flame Resistance: Comply with UL 1685 & NFPA 262
 - b. UL Temperature Rating: 75°C Dry, 90°C wet (167°F dry, 194°F wet).
 - c. ICEA S-73-532, S-61-402
3. Project Use Areas:
 - a. Use cable for control circuiting requiring one shielded twisted pair from a control panel to a field instrument or similar application.
4. Manufacturer:
 - a. Service Wire Co.
 - b. Okonite Co.
 - c. Southwire
 - d. Belden
 - e. Alpha Wire

E. Type D2 - Singlemode Fiber Optic Cable

1. Fiber optic cable shall be single-mode type with the following minimum requirements:
 - a. Tight Buffer OS1 type: Indoor application
 - b. Loose Tube OS2 type: Indoor/Outdoor Application
 - c. Dielectric design with PVC jacket suitable for installing in outdoor duct and is also rated for indoor use, thereby eliminating the service entrance splicing to in-building cable. Multi-tube design with multiple fibers per cable. Color-coded fibers and color-coded tubes. Fillers shall be provided in place of tubes, depending on fiber count, for round overall cable.
 - d. Maximum optical attenuation of fibers shall not exceed the following values:
 - 1) Wavelength Attenuation(dB/km)
 - a) OS1: 1.0
 - b) OS2: 0.4
 - e. Binder layer with strength member and black medium density of high-density polyethylene outer jacket with rip cord.

- f. Operating temperature range of -40°C to 70°C. (-40°F to 158°F).
 - g. Suitable for continuous submerged application and compatible with fiber optic communications modules used on project and with "LC" type connectors.
 - h. Manufactured in lengths to prevent splices.
- 2. Project Use Areas:
 - a. Network circuiting as defined on the cable and conduit schedules.
- 3. Manufacturer:
 - a. Belden
 - b. OCC
 - c. Corning

F. Type D3 - Cat 6 Shielded Ethernet Cable

- 1. EIA/TIA Category 6, 4-pair, #23 AWG, and a 600V rating
- 2. FEP Teflon plenum rated premise wiring cable where required.
- 3. Characteristics:
 - a. Industrial grade PO insulation
 - b. Minimum of 100% overall foil shielding coverage
 - c. PVC inner and out jackets
 - d. Outdoor rated
- 4. Category 6 cables shall be terminated in eight-conductor TIA-568-B CAT6, RJ-45 compliant snagless modular connectors.
- 5. The cable jacket and RJ45 terminator color shall be:
 - a. SCADA Network: Black Jack with Orange adhesive jack label
- 6. Project Use Areas:
 - a. Network circuiting as defined on the cable and conduit schedule and network switch schedule
- 7. Manufacturer:
 - a. Belden 7953A

G. Type D4 - Cat 6 Ethernet Cable

- 1. EIA/TIA Category 6, 4-pair, #23 AWG, and the voltage rating is application dependent
- 2. FEP Teflon plenum rated premise wiring cable where required.
- 3. Category 6 cables shall be terminated in eight-conductor TIA-568-B CAT6, RJ-45 compliant snagless modular connectors.
- 4. The cable jacket and RJ45 terminator color shall be:
 - a. SCADA Network: Orange
- 5. Project Use Areas:
 - a. Network circuiting as defined on the cable and conduit schedule and network switch schedule
- 6. Manufacturer:
 - a. Belden
 - b. Mohawk/CDT
 - c. Approved Equal

2.02 CORD CONNECTOR GRIPS

- A. Manufacturer: Eaton Crouse-Hinds CGB
- B. Type: Aluminum cord connector, stainless steel mesh grips where required, straight or 90° as required in eliminating sharp cable bending radii.
- C. Use: To support cables/cords from the enclosure at their point of use and/or wherever cables/cords enter or leave the bottom of conduit risers (above grade). Required for cord connections to motors or enclosures.

2.03 BOLTED, PRESSURE TYPE CONNECTORS

- A. Manufacturer:
 - 1. Burndy.
- B. Use: Connecting conductors to busbars, suitable for copper and aluminum conductors.
- C. Size: As required for conductor.

2.04 SOLDERLESS CONNECTORS

- A. Manufacturer:
 - 1. 3M "Scotchlok"
- B. Type: Twist-on, spring tension.
- C. Use: With copper conductors only.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Conductors shall be installed within conduit or approved raceway unless noted otherwise.
- B. Draw conductors into conduit only after conduit system is complete. Install in a manner so as not to injure insulation.
- C. Use stranded, copper conductors only. Solid conductors are not acceptable.
- D. Make splices on branch circuit conductors with solderless stapleless, mechanical wire connectors.
- E. Tighten bolted, pressure type connectors to manufacturer's recommendations.
- F. #10 AWG and smaller shall be stranded copper for motor and control circuits. Branch circuits for lighting and convenience outlets shall be solid copper.
- G. Branch circuit homeruns greater than 50 feet shall be #10 AWG minimum.

- H. Multiwire branch circuits shall have their neutral conductor increased 1 size relative to the phase conductors (i.e. if the phase conductors are #12 AWG, then the neutral shall be #10 AWG).
- I. Make splices and terminations in control panel by using bolted, pressure type connections. Install according to manufacturer's recommendations.
- J. Provide strain relief cord connectors and stainless-steel mesh on cords entering motor termination boxes, junction boxes or conduits.
- K. Use factory color coded conductors with separate color for each phase and neutral conductor by integral pigmentation for conductor sizes.
- L. Use the following color codes:

CONDUCTOR SYSTEM VOLTAGE-120/240, SINGLE PHASE

Phase A	Black
Phase B	Red
Neutral	White
Equipment Ground	Green

CONDUCTOR SYSTEM VOLTAGE-277/480, THREE PHASE

Phase A	Brown
Phase B	Orange
Phase C	Yellow
Neutral	Gray
Equipment Ground	Green

- M. Lace or clip groups of feeder conductors in control panels, pull boxes, and wireways.
- N. Use wiring pulling lubricant for pulling #4 AWG and larger wire.
- O. Splice only in accessible junction or outlet boxes.
- P. VFD Output Circuit Requirements:
 - 1. VFD output circuits shall be installed via one of the following methods at the Contractor's option:
 - a. Building wire in dedicated rigid steel conduit.
 - 1) Type P1 cable is not acceptable.
 - 2) Must be one of the following types:
 - a) RHH
 - b) RHW
 - c) RHW-2
 - d) XHH

- e) XHHW
 - f) XHHW-2
 - g) Other approved types according to NFPA 79 and other applicable standards.
- b. Type P4 Specialty shielded VFD cable in Sch. 80 PVC conduit below grade, and rigid metal/aluminum conduit above grade.
- 2. The ground conductor(s) from the VFD output shall be bonded to the motor frame or motor/equipment ground lug.
- 3. Each VFD output circuit shall be installed in its own dedicated conduit. No sharing of circuitry with VFD output power conductors in a common conduit or raceway system is allowed.
- 4. Ensure submersible well casing has been bonded to the VFD ground in accordance with manufacturer requirements, and applicable standards.
- 5. VFD output circuitry shall be installed to minimize their proximity to other power, signal and control circuits. A minimum separation of 6 inches is suggested between exposed VFD output circuits and other circuits in junction boxes, panels, MCCs, etc. Long parallel runs (10 feet or longer) of VFD output conductors with other circuits are not suggested or allowed. Maximum separation (more than 6") and maximum shielding (via metal conduit or shielded output cable) methods of installation shall be utilized wherever possible. Extra costs for installation revisions due to the inadequacy of the installed VFD output circuit separation and shielding will not be considered. It is the Contractor's responsibility to provide a complete and fully functioning VFD system with no output circuit interference, noise, crosstalk, etc.

3.02 CABLE INSTALLATION CERTIFICATIONS

- A. Installations and terminations of Ethernet and Fiber Optic network cabling shall be performed by BICSI Installer 2 certified installers with INSTC and INSTF certifications.
- B. Contractor shall submit installer certification to project engineer prior to installation of any network cabling.

3.03 CABLE TESTING

- A. Type D1 and D2 Cable - Fiber Optic Cable Splicing and Testing
 - 1. Single mode and multimode fiber strands shall be tested end to end for bidirectional attenuation in compliance with EIA/TIA-526-14 or OFSTP 14, Method B, according to the manufacturer's instructions for the test set being utilized. Provide test equipment, labor and materials for testing project fibers. Submit cable test records for each fiber, identifying the following information:
 - a. Date and time of test.
 - b. Name of test technician and company.

- c. Name of test witnesses.
 - d. Location of test.
 - e. Location of fiber ends.
 - f. Recorded test results:
 - 1) Fiber distance (measured using test instrumentation).
 - 2) Loss (attenuation) in dB at 850nm, 1300nm wavelengths for multimode and 1310nm and 1550nm for singlemode.
 - 3) Reflection in dB at 850nm, 1300nm wavelengths.
 - g. Submit photographs and screen traces where applicable.
2. Tests shall ensure that the measured link loss for each strand does not exceed the “worst case” allowable loss defined as the sum of the connector loss and the optical loss.
- a. After termination, each fiber shall be tested with an ODTR for length, transmission anomalies and end-to-end attenuation.
 - b. After termination and bulkhead mounting, each terminated fiber shall be tested for end-to-end loss with a power meter/light source.

3. Maximum optical attenuation of fibers shall not exceed the following values:

Fiber Type	Wavelength (nm)	Attenuation (dB/km)
Multimode (62.5/125 micron)	850	3.0
Multimode (62.5/125 micron)	1300	0.9
Singlemode (8.3/125 micron)	1310	0.35 (outside plant)
Singlemode (8.3/125 micron)	1310	1.0 (inside plant)
Singlemode (8.3/125 micron)	1550	0.2 (outside plant)
Singlemode (8.3/125 micron)	1550	1.0 (inside plant)

4. Type 'LC' connectors shall meet or exceed at 1300nm wavelength:
- a. Loss - less than 0.20dB
 - b. Reflection - less than -25dB
5. Splices (if required) shall be made using a precision fusion splicer resulting in splice performance that meets or exceeds:
- a. Loss - less than 0.03dB
 - b. Reflection - less than -60dB
6. Fibers having test results that do not meet the requirements shall be retested and/or replaced with new fiber. Fiber shall be retested until the fiber meets requirements. Minimum requirements shall be determined by adding total allowable losses and reflectance's for the number of splices (if any) and 'LC' connectors in each run.

B. Type D3 Cable - Telephone and LAN Category 5e Cable Testing

1. Perform end to end tests of each voice and data cable installed as follows:
 - a. Pair/conductor for proper pinouts and continuity.
 - b. Ground fault.
 - c. Proper termination, shorts and crossed pairs.
 - d. Channel attenuation per ANSI/TIA/EIA-568-A-5 and TSB-95.
 - e. Channel bidirectional worst case near end cross talk (NEXT) at frequencies up to 100 MHZ, per the standards listed in Item 4.
 - f. Measured and documented effective cable run length for each circuit.
 - g. Submit record of test results to Owner and Engineer.

C. Type D4 Cable - Telephone and LAN Category 6 Cable Testing

1. Perform end to end tests of each voice and data cable installed as follows:
 - a. Pair/conductor for proper pinouts and continuity.
 - b. Ground fault.
 - c. Proper termination, shorts and crossed pairs.
 - d. Channel attenuation per ANSI/TIA/EIA-568-A-5 and TSB-95.
 - e. Channel bidirectional worst case near end cross talk (NEXT) at frequencies up to 100 MHZ, per the standards listed in Item 4.
 - f. Measured and documented effective cable run length for each circuit.
 - g. Submit record of test results to Owner and Engineer.

D. OTHER NETWORK CABLE TESTING

1. Perform end to end tests of each other specialty network cable installed as coordinated with the cable/system manufacturer and including the following:
 - a. Pair/conductor for proper pinouts and continuity.
 - b. Ground fault.
 - c. Proper termination, shorts and crossed pairs.
 - d. Channel attenuation per manufacturer and industry standards.
 - e. Channel bidirectional worst case near end cross talk at frequencies up to 100 MHZ, per the standards listed in Item 4.
 - f. Measured and documented effective cable run length for each circuit.
 - g. Other tests as recommended by the manufacturer and industry standards for each specific cable/system type.
 - h. Submit record of test results to Owner and Engineer.

3.04 QUALITY CONTROL AND DOCUMENTATION

A. The Contractor shall submit a **Fiber Optic Quality Control Plan** describing:

1. Installation methods and handling procedures.
2. Splicing and termination practices.
3. Labeling and identification standards.

4. Testing procedures and acceptance criteria.
5. Documentation and as-built deliverables.

B. Final acceptance shall require:

1. OTDR traces for all fiber strands.
2. End-to-end loss test results.
3. Splice enclosure and termination panel documentation.
4. As-built drawings in both PDF and native CAD/GIS format (if applicable).

END OF SECTION 26 05 19

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SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Grounding system for electrical equipment. Equipotential ground loop around perimeter of building(s) and bond to main service equipment. Provide ground bars and ground test wells at locations indicated on the Drawings.

1.02 DESCRIPTION OF SYSTEM

- A. Bond electrical equipment, control panels, panelboards, etc. to the metallic conduit system through conduit connectors or bonding jumpers, as required, to provide effective electrical continuity.

1.03 QUALITY ASSURANCE

- A. NFPA 70 (National Electrical Code), article 250.

PART 2 - PRODUCTS

2.01 GROUNDING CONDUCTORS

- A. Copper, with green identification as specified in Section 26 05 19 - Power and Instrumentation Cable - Less Than 600V.

2.02 GROUND RODS

- A. Type: Copper clad steel, 5/8-inch diameter, 10 feet long.

2.03 GROUND CLAMPS (CONCEALED)

- A. Compression type grounding which meets IEEE 837.
- B. Manufacturer: Panduit StructuredGround

2.04 GROUND FITTINGS AND LUGS (EXPOSED)

- A. Manufacturer: Burndy Company

2.05 GROUND LUG

- A. Located in electrical equipment.

PART 3 - EXECUTION

3.01 POWER SYSTEM GROUNDING

A. Main Service

1. Provide a grounding grid consisting of driven ground rods with bare stranded copper interconnecting conductor and a connection to water service ground as indicated on the Drawings. Bare copper conductor shall be of size as shown on the Drawings. From two points on the ground grid, provide ground conductor to the ground bars indicated on the Drawings. From the service ground bus, provide ground conductor to neutral of main service (main bonding jumper strap). Bond equipment to equipotential ground plane where noted on the Drawings.

B. Distribution System

1. Install grounding bars and grounding studs at locations indicated within the facility, distribution centers, pull boxes and panelboards. Bond metallic conduit systems and metallic piping with metallic clamps and bonding conductor for ground continuity.

C. Provide a properly sized copper grounding conductor in branch circuit and feeder conduits. Size the conductor according to Table 250-122 of the National Electric Code. Connect the grounding conductor to grounding points (grounding bars, ground studs, etc.) in electrical enclosures, electrical equipment, junction boxes, and outlet boxes.

D. Ground and bond in accordance with National Electric Code, Article 250.

END OF SECTION 26 05 26

SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Support and attachment requirements and components for equipment, conduit, cable, boxes, and other electrical work.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2023.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2023.
- D. ASTM D635 - Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position; 2022.
- E. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2026a.
- F. MFMA-4 - Metal Framing Standards Publication; 2004.
- G. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.03 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.

5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured.

1.04 SUBMITTALS

- A. Submit the following:
1. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
 - a. Fiberglass Channel (Strut) Framing Systems: Include requirements for strength derating according to ambient temperature.
 2. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
 3. Derating Calculations for Fiberglass Channel (Strut) Framing Systems: Indicate load ratings adjusted for applicable service conditions.
 4. Evaluation Reports: For products specified as requiring evaluation and recognition by ICC Evaluation Service, LLC (ICC-ES), provide current ICC-ES evaluation reports upon request.
 5. Installer's Qualification Statement: Include certification of compliance with specified requirements.
 6. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE

- A. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- B. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:

1. Provide required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Indoor Dry Locations: Use hot dipped galvanized materials unless otherwise indicated on the Drawings.
 - b. Outdoor and Damp or Wet Indoor Locations: Use 304 stainless steel unless otherwise indicated on the Drawings.
 - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

- B. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.

1. Conduit Straps: One-hole or two-hole type; steel, malleable iron, or 304 stainless steel as noted on the Drawings for each area.
2. Conduit Clamps: Bolted type unless otherwise indicated.
3. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - e. Thomas & Betts Corporation: www.tnb.com.
 - f. Prior approved equal

- C. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
1. Manufacturers:
 - a. Cooper Crouse-Hinds, a division of Eaton Corporation: www.cooperindustries.com.
 - b. Erico International Corporation: www.erico.com.
 - c. HoldRite, a brand of Reliance Worldwide Corporation: www.holdrite.com.
 - d. O-Z/Gedney, a brand of Emerson Electric Co: www.emerson.com.
 - e. Thomas & Betts Corporation: www.tnb.com.
 - f. Prior approved equal
- D. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
 2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
 3. Channel Material:
 - a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
- E. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Hollow Masonry: Use toggle bolts.
 5. Hollow Stud Walls: Use toggle bolts.
 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 7. Sheet Metal: Use sheet metal screws.
 8. Wood: Use wood screws.
 9. Plastic and lead anchors are not permitted.
 10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch (2.66 mm) minimum base metal thickness.

- d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
- 11. Post-Installed Concrete and Masonry Anchors: Evaluated and recognized by ICC Evaluation Service, LLC (ICC-ES) for compliance with applicable building code.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that field measurements are as indicated.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Install anchors and fasteners in accordance with ICC Evaluation Services, LLC (ICC-ES) evaluation report conditions of use where applicable.
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

- H. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

END OF SECTION 26 05 29

SECTION 26 05 34
CONDUIT

PART 1 - GENERAL

1.01 SUMMARY

- A. Conduit system for conductors. Low voltage control conductors and fiber optic cabling shall be installed within conduit.

1.02 REFERENCE STANDARDS

- A. UL 6 - Rigid metal conduit.
- B. UL 360 - Liquid-tight flexible steel conduit.
- C. UL 651 - Rigid non-metallic conduit.
- D. UL 1203 - Explosion-Proof Electrical Equipment for use in Hazardous Locations
- E. NEMA Standard Publication TC-2 - Rigid PVC for underground installations.
- F. NEMA Standard Publication RN 1-2005 – PVC coated rigid steel conduit.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Store in a dry area, protected from the weather.

1.04 SUBMITTALS

- A. Submit product data and shop drawings in accordance with Specification Section 01 33 00 - Submittal Procedures.

PART 2 - PRODUCTS

2.01 RIGID METAL CONDUIT (STEEL)

- A. Manufacturer: Wheatland Steel Company
- B. Type: Steel heavy wall; galvanized unless noted otherwise on Drawings.

2.02 RIGID METAL CONDUIT (ALUMINUM)

- A. Manufacturer: Wheatland Steel Company
- B. Type: 6063 aluminum alloy, T-1 temper, marine grade.
- C. Manufactured in accordance with ANSI C80.5, UL 6A.

2.03 PVC COATED RIGID CONDUIT

- A. Manufacturer: Plasti-Bond
 - B. Type:
 - 1. PVC externally coated, 6063 alloy rigid aluminum conduit
 - C. The PVC coated galvanized rigid conduit shall be ETL verified to the Intertek ETL SEMKO High Temperature H2O PVC Coating Adhesion Test Procedure for 200 hours. The PVC coated galvanized rigid conduit shall bear the ETL verified PVC-001 label to signify compliance to the adhesion performance standard.
- 2.04 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)
- A. Manufacturer: Alfex
 - B. Type: Steel
 - C. Weatherproof covering.
- 2.05 NON-METALLIC CONDUIT - PVC (HEAVY WALL)
- A. Manufacturer: Carlon.
 - B. Type: Sch. 80 PVC, except where Sch. 40 is specified on Drawings.
- 2.06 HIGH-DENSITY POLYETHYLENE (HDPE) FIBER OPTIC DUCT
- A. Flexible, high-density polyethylene (HDPE) in accordance with ASTM F 2160 SDR and NEMA TC standards. Size as noted on the Drawings, and minimum wall thickness which meets ASTM D3035 for the size noted.
 - B. Smooth interior wall design (innerduct) with orange color throughout.
 - C. Manufacturer:
 - 1. Carlon
 - 2. Vikimatic
 - 3. Blue Diamond Industries
- 2.07 ELECTRICAL METALLIC TUBING (EMT)
- A. Manufacturer: Wheatland Steel Company
 - B. Type: Steel
- 2.08 EXPANSION FITTINGS
- A. Manufacturer: OZ Electrical Manufacturing Company.
 - B. Material type shall match conduit.

2.09 HANGERS AND SUPPORTS

- A. Manufacturer: B-Line Products.

2.10 SURFACE METAL WIREWAY

- A. Manufacturer: Hoffman or Walker
- B. Type: Lay-in with hinged cover and suitable fittings. Provide integral barrier where shown on the Drawings.
- C. NEMA 12, NEMA 4, or NEMA 4X construction as called for on Drawings.
- D. Areas noted as Class I, Division 1, Group D or Class I, Division 2, Group D shall require equipment listed for use in those specific areas.

2.11 CONDUIT SEALS

- A. Manufacturer: Appleton.
- B. Provide listed seal offs throughout Class I, Division 1, Group D or Class I, Division 2, Group D areas per NEC Articles 500 and 501.
- C. Seals shall be field marked when poured.

2.12 NON-METALLIC EXPANSION FITTINGS

- A. Manufacturer: Carlon.
- B. Type: Suitable for use with nonmetallic conduit.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

- A. Size conduits as shown on the Drawings or as required by National Electrical Code (whichever is larger) for number and size of conductors installed. Minimum trade size is 3/4-inch; other sizes as required by NEC based on quantity of conductors.
- B. Contractor shall not exceed 270 degrees of bend in any single conduit run without an additional pull point.
- C. Raceways shall have an equipment ground conductor installed. The raceway shall not be utilized as an EGC.
- D. Support conduits from structural system, independent of ductwork, ceiling system supports, and main runners. Do not support conduit from conduit. Tie wires to hang or strap conduits are not permitted.

- E. Cut conduit joints square and ream smooth. Make bends with abender or utilize standard conduit elbows.
- F. For buildings where walls are concrete or concrete blocks, Contractor shall core drill walls or coordinate reinforced, boxed out areas as required to install conduit in a neat and workmanlike manner. Contractor shall patch wall penetrations and prepare the surface for final paint.
- G. Contractor shall provide sleeves or reinforced concrete boxed out openings through footings for underground conduits. Coordinate with General Contractor.
- H. Securely fasten conduit and raceways with clamps with clamp backs, in order to keep an air gap between conduit and finished wall surfaces to reduce the potential of moisture induced corrosion. Anchors shall be lead, expansion type with stainless steel hardware. Route conduits parallel to and at right angles to building lines. Conduits mounted directly in contact with wall surface shall not be acceptable. Utilize unistrut and clamps using materials as shown below unless otherwise noted on the Drawings.

Indoor Dry Areas	hot dipped galvanized
Indoor damp/corrosive Areas	316 stainless steel
Exterior Areas	316 stainless steel and fiberglass

- I. Route conduit continuous from outlet to outlet, outlet to cabinets, outlet to pull or junction boxes. Secure conduit to boxes with locknuts and bushings in such a manner to ensure each system is electrically continuous throughout.
- J. Surface mount conduit in areas, unless noted otherwise. Conduits and outlet boxes on the building exterior shall be flush mounted where possible. If not, install conduits within the building and then penetrate the wall directly into the back of light/outlet/etc. Intent is to eliminate/minimize the usage of surface mounted conduit on the exterior face of the building.
- K. Cap ends of conduit to prevent entrance of foreign materials during construction.
- L. Locate conduits poured in concrete entirely in the middle 1/3 of the concrete member.
- M. Provide a 4-inch-high watertight barrier for conduits that pass vertically through a floor with a metal sleeve or concrete curb.
- N. Provide "link seal" around conduits penetrating exterior walls/foundations and wet wells. Nuts on the link seal shall remain accessible from inside the building once link seal is installed. Non shrinking grout is acceptable for penetrations above finished grade.

- O. Below grade non-metallic conduit shall be transitioned to PVC Coated Rigid Steel before exposing above grade. Transition shall be made via below grade transition couplings to PVC Coated Rigid Steel elbows/sweeps.
- P. Conduits routed in hazards areas shall be rigid aluminum unless noted otherwise. Mount aluminum conduit on fiberglass strut with aluminum conduit straps only.
- Q. Provide watertight installation where conduits pass through roof, wall, or waterproofing membranes.
- R. Conduit systems shall be installed completely before conductors are pulled in.
- S. Repair damage to insulation or interior vapor barrier where conduit enters air plenums.
- T. Fill conduits which can admit air to or release air from air plenums through the connecting conduit system with sealing compound.
- U. Provide firestopping around conduits penetrating fire rated walls.
- V. Conduits used shall be of the Form 7 type or equivalent.

3.02 RIGID METAL CONDUIT (STEEL)

- A. Rigid metal conduit shall be permitted in floor slabs or as specifically called for on the drawings.
- B. Rigid metal conduit shall be required for exposed conduits unless otherwise noted on the Drawings.
- C. Paint rigid metal conduit that is in contact with earth with coat of bitumastic paint. Paint couplings after assembly. Where bitumastic paint is applied the paint shall be thoroughly dried before backfilling.
- D. Fittings type shall be threaded. Use threaded hubs (Myers hub) where rigid conduit is connected to a thread less box or enclosure for indoor and outdoor applications. Lock nut with O-Ring is not acceptable.

3.03 RIGID METAL CONDUIT (ALUMINUM)

- A. Rigid aluminum conduit shall be required for exposed conduits and shall not come in contact with soil or concrete wall surfaces.
- B. Install on fiberglass strut stand offs such that the conduit does not come into contact with concrete. When passing through a slab, ensure conduit is properly wrapped as per conduit supplier recommendations.

- C. Fittings type shall be threaded. Use threaded hubs (Myers hub) where rigid conduit is connected to a thread less box or enclosure for indoor and outdoor applications. Lock nut with O-Ring is not acceptable. Fittings that come in contact with stainless steel shall be galvanized steel per NEC 344.14.

3.04 PVC EXTERNALLY COATED RIGID CONDUIT

- A. Clamping, cutting, threading, bending, and assembly instructions listed in the manufacturer's installation guide shall be followed.

3.05 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

- A. Use rain tight flexible metal conduit with rain tight fittings for final connections to motors (non-hazardous areas), and field instrumentation (non-hazardous areas) that do not come with factory installed cords. Minimum trade size is 1/2".
- B. LFMC with seal-off may be used in Class 1 Division 2 & Class 2 occupancies where permitted per NEC 501.10 (B)(2) & 502.10 (A) (2). Flexible metal conduit used in Class I, Division 1 occupancies require explosion proof listing (metal braided) with listed fittings for final connections to motors (hazardous areas), and fixed control devices (hazardous areas). Minimum trade size is 3/4".
- C. Length shall be limited to trade size: 3/4" or less = 36"; 1" or larger = 48". Minimum 12". Use permitted only to avoid transmission of vibration or noise and where flexibility to entry is required. Other uses shall be approved by the Engineer.
- D. Engineer reserves the right to request re-work of any flexible metal conduit that exceeds specified lengths or is installed where not permitted as noted above.
- E. Flexible Metal Conduit shall not be used to transition through walls under any circumstance.

3.06 NON-METALLIC CONDUIT - PVC (HEAVY WALL)

- A. Use rigid non-metallic, Sch. 80 PVC conduit for direct burial and exposed wet, caustic, or corrosive installations unless specifically noted otherwise on Drawings.
- B. Cut conduit square with round edges removed from ends to protect the wires from abrasion. Make connections by solvent welding. Install fittings in accordance with the manufacturer's recommended procedures. Elbows 2" and larger shall be rigid metal conduit. Provide expansion joints where there are long runs of conduit, and a wide temperature differential exists. Use PVC coated RMC sweeps when penetrating through concrete floors.
- C. Provide grounding conductor in control circuits, branch circuits, and feeder conduits.

- D. Typical applications include underground and in chemical or caustic areas.

3.07 HIGH-DENSITY POLYETHYLENE (HDPE) FIBER OPTIC DUCT

- A. Install SDR 13.5HDPE fiber duct where shown on the Drawings. Furnish and install water-tight couplings and/or fittings for connecting the HDPE duct system to the conduit systems for entrance to/from the buildings. Furnish and install at grade handholes and above grade pull boxes as indicated on the Drawings.
- B. HDPE Duct to HDPE Duct splices shall be performed using heat-fused connections.
- C. Contractor shall furnish and install the required fiber optic communication cable.
- D. Contractor shall install a #8 AWG copper tracer wire with Type HMWPE insulation, red in color, for each duct installed.
- E. HDPE duct shall be installed per the duct manufacturer's recommendations and requirements at a minimum depth of as noted on the Drawings. Duct shall be continuous from point to point (junction box to junction box and junction box to building entrance). Provide on reels of adequate length so that splicing is not required between handholes and building entrances. Remove stones and debris from the duct trench (as applicable) and shall fill in any voids with sand prior to placement (as applicable). Use care in placement of the duct as well as during backfilling and compacting so as not to damage the duct.
- F. The duct shall not be allowed to bend or kink sharper than the minimum bending radii as published by both the duct manufacturer and the fiber optic cable manufacturer.

3.08 ELECTRICAL METALLIC TUBING (EMT)

- A. Electrical metallic tubing is only permitted where specifically indicated on the Drawings.
- B. Electrical metallic tubing (EMT) is only permitted in the following areas:
 - 1. New Electrical Building (EB)
- C. Where EMT tubing is allowed, stamped steel boxes are acceptable.

3.09 CAST IN PLACE CONDUIT INSTALLATION REQUIREMENTS

- A. Conduits installed under the concrete floor within the extents of the building footprint shall not be acceptable unless specifically called out on drawings.
- B. Structures with deep basements and foundation systems consisting of piles/screwed piers with grade beams and void forms shall have no conduits under the concrete floor.

- C. Where conduits transition from below the concrete floor to above, vertically oriented couplings installed below slab shall be with threaded PVC coated rigid type. Other conduit types shall have no vertical couplings and be seamless and continuous from horizontal coupling to above concrete floor.
 - 1. Do not route conduits through wet wells, clearwells, underground tanks, etc. unless required to feed equipment located within the same. Use PVC coated RMC or RTRC type XW sweeps whenever penetrating concrete floors or through below grade footings, etc. Schedule 80 PVC or RTRC type conduits shall be used under or cast into concrete floor slabs.
- D. Schedule 40 PVC conduit shall be acceptable in concrete encased ductbanks.
- E. VFD Output Circuits, Signal Circuits, and Data Circuits shall be installed in rigid conduit.
- F. VFD Output Circuits and Signal Circuits shall utilize shielded VFD cable and shielded signal cable respectively.
- G. Contractor shall submit a cast-in-place conduit routing plan showing conduit routes, sizes and quantity to Structural Engineer prior to any cast-in-place installation taking place.

3.10 CONDUIT COLOR

- A. Color-coded conduit shall be utilized as noted below. EMT conduit shall be colored from the factory while RMC shall be painted on site.
 - 1. Blue - Network Cabling Circuits

3.11 AT GRADE FIBER HANDHOLES

- A. Furnish and install precast fiber handholes in quantity and type as indicated on the Drawings.

3.12 CONDUIT TYPES PERMITTED BY APPLICATION

- A. Ensure that conduits and installations comply with the NEC, are certified and listed for their intended use, and are suitable for the environmental and operational demands of the application. Depending on the specific application, additional precautions may be required, such as applying corrosion-resistant coatings, special paint, or protective coverings to ensure durability and compliance in wet or corrosive environments. For installations in hazardous locations, the conduit shall also meet the specific requirements for classified areas, including explosion-proof ratings.
 - 1. General interior areas: RMC (Steel)
 - 2. Outdoor/Wet Environment: RMC (Steel)

3. Caustic/Corrosive Environment: PVC (Sch. 80)
4. Buried in Earth: PVC (Sch. 80)
5. Installed in Duct Bank: PVC (Sch. 40)
6. C1D1 areas: RMC (Steel) and RMC (Aluminum)
7. C1D2 areas: RMC (Steel) and RMC (Aluminum)
8. Underground fiber: HDPE

END OF SECTION 26 05 34

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SECTION 26 05 37
BOXES

PART 1 - GENERAL

1.01 SUMMARY

- A. Outlet boxes, junction boxes and pull boxes required to accomplish device and equipment installation, wire pulling shown on the Drawings and to comply with National Electric Code requirements for conduit and conductor installation.

1.02 DELIVERY, STORAGE AND HANDLING:

- A. Store materials in a dry area, protected from the weather.

PART 2 - PRODUCTS

2.01 PULL BOXES

- A. Manufacturer: Hoffman
- B. Type: Metal construction, conforming to National Electrical Code, with screw on or hinged cover.
- C. NEMA type 12, 4, 4X, 7 enclosure.
- D. Overlapping covers with flush head cover retaining screws, prime coated for flush mounted pull boxes.

2.02 SURFACE MOUNTED OUTLETS

- A. Manufacturer: Crouse Hinds, Appleton.
- B. Type: FS or FD Condulet Cast Device Boxes (# gangs as required).
- C. Matching iron alloy (Feraloy) covers as required for device(s) used.
- D. All outlets/boxes, and fittings in Class I, Division 1, Group D, or Class I, Division 2, Group D areas shall be listed for use in those respective areas as noted on drawings.
- E. Outlets/boxes, and fittings in Classified Locations shall be listed for use in the respective areas.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Avoid potential obstructions within dedicated equipment spaces and work clearances as defined in the NEC.

- B. Clean interior of boxes to remove dirt, debris, and other foreign materials.
- C. Do not use sectional or handy boxes.
- D. Protect outlet boxes from entrance of foreign materials, including paint.
- E. Surface mount interior outlet boxes.
- F. Provide seal offs per NEC Articles 500 and 501 as required.
- G. Install outlets at the heights and approximate designated positions as shown on the Drawings unless specifically noted otherwise.
- H. Locate outlets to clear piping, access hatches, and other obstructions.
- I. Install switch outlets on latch side of door except where type of construction dictates otherwise.
- J. Mounting heights indicated on Drawings are to center line of outlet unless indicated otherwise.
- K. Pull boxes and junction boxes are not indicated on Drawings except for special requirements. Install pull boxes or junction boxes as required to facilitate pulling wire. Size pull boxes and junction boxes as required by the National Electrical Code.
- L. Mount receptacles in the equipment rooms and in other unfinished areas at 48 inches unless noted otherwise. Match mounting heights of similar existing devices in the immediate area if present.
- M. Conduits entering pull boxes shall have the conduit ID as shown on the cable and conduit schedule clearly labeled on the inside of the pull box using permanent marker.
- N. Provide ventilated skirt under junction boxes where indicated.

END OF SECTION 26 05 37

SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Identification includes panelboards, disconnects, transformers, relays, contactors, system control panels, variable frequency drives, separately mounted control stations, pilot lights, control switches, wires, and terminations.

1.02 REFERENCE STANDARDS

- A. NFPA 70 - National Electrical Code (NEC).
- B. OSHA

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION LABELS

- A. Mechanically fastened, engraved, laminated acrylic or melamine label.
- B. Color: Black with white letters.
- C. Letters: 3/8-inch minimum height, standard block type.
- D. Punched or drilled for mechanical fasteners. Fasteners shall be self-tapping stainless-steel screws with nuts and flat lock washers.

2.02 WIRE MARKERS

- A. Wires requiring circuit indication shall be permanently fastened type written. Handwritten labels shall not be acceptable.
- B. Wire markers shall be Shrink Tube or Self Laminating type.
- C. Shrink Tubing type wire markers:
 - 1. Shrink tube type markers shall be type written with circuit indication.
 - 2. 3:1 heat-shrinking type
 - 3. Resistant to chemicals, grease, oil and cleaning agents.
 - 4. Material shall be Polyolefin with smudge-proof finish.
 - 5. Material shall be cold resistant and flame-retardant
 - 6. Temperature range: -67 to 275 degrees Fahrenheit.
 - 7. Manufacturer: Brady
- D. Self-laminating type wire markers:

1. Self-laminating type markers shall be type written with circuit indication
2. Vinyl label with acrylic adhesive
3. Label shall have overlamine included sized appropriately to wrap cable one and a half times or completely cover printed area, whichever is greater.
4. Label shall be rated for indoor and outdoor use.
5. Temperature range: -94 to 140 degrees Fahrenheit.
6. Material shall be flame-retardant.
7. Resistant to chemicals, humidity, oil, water and weather.
8. Manufacturer: Brady

2.03 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and OSHA 29 CFR 1910.145.
- B. Self-adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated. Weather resistant, non-fading, metal backed or baked enamel signs shall be used for outdoor installations.

2.04 POWER SOURCE LABELS FOR EQUIPMENT AND DEVICES

- A. Mechanically fastened label, installed on the front cover, door, or other access to equipment and devices unless otherwise indicated. Weather resistant, non-fading, metal backed or baked enamel signs to be used for outdoor installations.
- B. Manufacturer: Brady or approved equal.
- C. Apply to panels, junction boxes, receptacle faceplates, switch faceplates, front covers, doors, or other access to equipment unless otherwise indicated.

2.05 CABLE AND CONDUIT IDENTIFICATION

- A. Cable or conduit shall be identified using a permanent identification system consisting of a round 304 stainless steel engraved tag secured to the cable or conduit 6" from entry at both ends. Install tag in suitable location readable from normally accessed side.
- B. The following information shall be provided on each conduit label:
 1. Line #1 - Conduit ID found on the Cable and Conduit Schedule (where applicable)
 2. Line #2: From: XXX (if a Cable and Conduit ID is not available)
 3. Line #3: To:XXX (if a Cable and Conduit ID is not available)

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Clean surface before installation of labels.
- B. Identify with black acrylic based placard with white engraved letters mounted with drive pins or other approved fasteners.

3.02 DISCONNECTS AND STARTER ENCLOSURES

- A. Use the following for identifying disconnects or starter enclosures per NEC 110.22 (A).
 - 1. EXAMPLE: Raw Wastewater Pump #1
480 volt, 3 phase, 300 H.P.
Fed from: DP-X, Pole Position XX

3.03 PANELBOARD LABELING

- A. Label per NEC Article 408.4 (A) & (B) and with the following information: Panel name, voltage, phase and amperage/type of main.
 - 1. EXAMPLE:
Panel L: Fed From: DP-X
120/208 volt
Three phase
225 amp Main Circuit Breaker
- B. Provide each panelboard (new or modified) with a typed directory, with clear plastic cover, of circuits describing loads served.
- C. Markings shall be plainly visible, fit over the insulation of the conductor and begin 1/8" from where the insulation begins.
- D. Wire markers shall be placed on both ends of wires prior to termination.
- E. Wiring shall be checked for circuit completeness to verify correct circuiting, identification and labeling at the terminals. Terminal markings and wire markings shall match record schematics.
- F. Hand lettering of identification not permitted. Completely remove temporary labels used during construction and repaint surfaces if required.

3.04 POWER SOURCE LABELS FOR EQUIPMENT AND DEVICES

- A. Provide a mechanically fastened power source label at equipment and devices with the following information:
 - 1. EXAMPLE: LPA-11 or LPA-13,15 or DPA-1,3,5.

- B. Equipment and devices such as panels, junction boxes, receptacle faceplates, switch faceplates, front covers, doors, or other access to equipment shall include an adhesive backed label that indicates the power source.

3.05 CONDUIT AND CIRCUIT LABELING AT POINT OF ENTRY TO LARGE ENCLOSURES

- A. Use a black permanent marker to hand label conduits and circuits at the point of entry to large enclosures (control panels, pullboxes, junction boxes, motor control centers, etc.) with the conduit/circuit number from the cable and conduit schedule.
- B. Labeling shall be on the interior of the enclosure or on the floor near each conduit/circuit, or on the conduit. Conduits/circuits that enter enclosures shall be labeled.
- C. Labeling with a permanent marker shall be in addition to circuit tags installed around the cables themselves.

3.06 GROUNDED (NEUTRAL) CONDUCTOR IDENTIFICATION

- A. Identify grounded conductors in accordance with NEC 200.6.
- B. In addition to the part (D) identification requirements for the grounded conductor when different systems are in close proximity - Example: Non-Emergency UPS and Utility power sharing a common junction box or multi-channel raceway. Where broken, to prevent crossing of grounded/neutral conductors, the non-utility system's neutral wires shall have wire markers identifying it as the system to which it belongs.

3.07 DRY TYPE TRANSFORMER

- A. Label per NEC Article 450.11 and with the following information: Transformer name, power source and circuit number, and loads served.
 - 1. Example: XFMR-1
Fed from: DP-X-12,14,16
Feeds LP-X

END OF SECTION 26 05 53

SECTION 26 09 14
ELECTRICAL POWER MONITORING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnish and install motor protection equipment to protect against motor loss due to low voltage, phase failure and phase reversal as shown on the Drawings. The work includes installing motor protection devices within the motor control center, conduit and conductors.
 - a. Solid-state electronic overload relays provided as part of combination motor starters shall be considered and equivalent equal to a separately installed motor protection relay. If solid state electronic overload relays are furnished and accurately programmed for the motor protection functions listed, separate motor protection relays are not required to be provided.

1.02 QUALITY ASSURANCE

- A. U.L. listed and installed according to the latest edition of the National Electric Code.

1.03 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures.
- B. Clearly indicate model number, line voltage, power consumption, operating points, delay time, output contact rating, weight and dimensions.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver to job site in standard cartons with labels intact.
- B. Store in dry area protected from the weather.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data including Shop Drawings in accordance with Specification Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.01 POWER MONITORING MODULES

- A. Manufacturer:

1. AllenBradley / PowerMonitor 5000
2. Eaton / Power Xpert 2000 (2290 Series)
3. Electro Industries Gauge Tech / Shark 200 (V6 Series)
4. Square D. / PM 8000
5. GE EPM 7000
6. ABB
7. Prior Approved Equal

B. Characteristics:

1. High visibility color graphical display.
2. Type: Microprocessor based providing multifunction measurement.
3. Self-contained with LED or LCD display.
4. Flush mounted on section door of switchgear, switchboard, motor control center or panelboard as indicated on the Drawings.
5. 0.2% Class Revenue Certificate meeting ANSI C12.20.
6. IEEE input withstand capability meeting IEEE C37.90.1
7. Includes KYZ pulse for output monitoring.
8. 256 samples per cycle, minimum.
9. 4 MB minimum flash (nonvolatile) memory for data storage / data logging.
10. Capable of performing harmonic compliance check for IEEE-519.
11. Includes an adjustable output alarm/trip relay contact for customer use.

C. Monitor and display the following electrical parameters:

1. AC line current (three phase)
2. AC line to line voltage (all phases)
3. AC line to neutral voltage (three phases)
4. Instantaneous operating watts
5. Instantaneous VARS
6. Instantaneous power factor
7. Peak operating watts
8. Instantaneous frequency
9. Watt hour consumption
10. Time and Date
11. Total Harmonic Distortion to the 31st fundamental

D. Unit shall maintain programs, setpoints and data logged throughout a power loss.

E. Factory assembled with C.T.'s prewired within equipment where indicated.
Provide shorting bars for C.T. removal and maintenance.

F. The unit's primary function is to monitor and display electrical parameters.

G. The unit's secondary function is to monitor parameters and if the tolerances are exceeded, a protective relay will enable an Internal Alarm and Trip Relay.

- H. The unit shall have an external Ethernet communication port for connecting to the plant SCADA System as indicated on the Drawings. Protocol for Ethernet shall be Modbus TCP/IP.

- 1. Provide 1 hour of Owner training for programming of the power monitor.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install power monitoring modules where shown on Drawings or called for elsewhere in Specifications.

END OF SECTION 26 09 14

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SECTION 26 22 13
GENERAL PURPOSE DRY-TYPE DISTRIBUTION TRANSFORMER (1500 KVA AND
BELOW)

PART 1 - GENERAL

1.01 SUMMARY

- A. The Contractor shall furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers of the two-windings type, self-cooled as specified herein, and as shown on the contract drawings.

1.02 REFERENCES

- A. The transformers and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of ANSI, NEMA and UL.
- B. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

1.03 SUBMITTALS – FOR REVIEW/APPROVAL

- A. Submit shop drawings in accordance with Specification Section 01 33 00 - Submittal Procedures including, at a minimum:
 - 1. Outline dimensions and weights
 - 2. Transformer ratings including:
 - a. kVA
 - b. Primary and secondary voltage
 - c. Taps
 - d. Basic impulse level (BIL) for equipment over 600 volts
 - e. Design impedance
 - f. Insulation class and temperature rise
 - g. Sound level.
 - 3. Product data sheets

1.04 SUBMITTALS – FOR CONSTRUCTION

- A. The following information shall be submitted for record purposes.
 - 1. Final as-built drawings and information for items listed in "SUBMITTALS - REVIEW/APPROVAL", and shall incorporate all changes made during the manufacturing process
 - 2. Connection diagrams
 - 3. Installation information
 - 4. Seismic certification and equipment anchorage details as specified

1.05 QUALIFICATIONS

- A. The manufacturer of the dry-type distribution transformers shall be the same as the manufacturer of the other major electrical distribution equipment on the project.
- B. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.
- C. The manufacturer shall be a participant in the UL Data Acceptance Program (DAP) under the Client Test Data Program (CTDP) certification to ensure UL test methodologies and record traceability complies with the requirements of ISO 17025.
- D. Transformer must bear the UL Energy Efficiency Verification Mark to confirm that the unit meets the requirements of 10 CFR Part 431.
- E. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years.

1.06 REGULATORY REQUIREMENTS

- A. All transformers shall be UL listed and bear the UL label.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

1.08 OPERATION AND MAINTENANCE MANUALS

- A. Equipment operation and maintenance manuals shall be provided with each assembly shipped and shall include instruction leaflets and instruction bulletins for the complete assembly and each major component. Manuals shall be in compliance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Eaton
- B. Square D
- C. Siemens
- D. General Electric

- E. ABB
- F. Sola/Heavy-duty

The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety. Products in compliance with the specification and manufactured by others not named will be considered only if pre-approved by the Engineer ten (10) days prior to bid date.

2.02 RATINGS

- A. The kVA and voltage ratings shall be as indicated on the drawings.
- B. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.
- C. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".
- D. Transformers efficiency shall be measured according to federal law 10 CFR Part 431.
- E. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self-cooled ratings:

Equivalent Winding kVA Range	Self-Cooled Ventilated		Self-Cooled Sealed
	K-Factor=1	K-Factor=13	
	K-Factor=4	K-Factor=20	
	K-Factor=9		
3.00 and below	40	40	45
3.01 to 9.00	40	40	45
9.01 to 15.00	45	45	50
15.01 to 30.00	45	45	50
30.01 to 50.00	45	48	50
50.01 to 75.00	50	53	55
75.01 to 112.50	50	53	55
112.51 to 150.00	50	53	55
150.01 to 225.00	55	58	57
225.01 to 300.00	55	58	57
300.01 to 500.00	60	63	59
500.01 to 700.00	62	65	61
700.01 to 1000.00	64	67	63
Greater than 1000	Consult Factory	Consult Factory	Consult Factory

- F. Where K-factor transformers are indicated on the drawings, the transformers shall be specifically designed to supply circuits with a harmonic profile equal to or less than a K-factor of 20 without exceeding 115 degrees C temperature rise.

2.03 CONSTRUCTION – GENERAL PURPOSE TRANSFORMERS

A. Insulation Systems

1. Transformer insulation system shall be as follows:
 - a. Less than 15 kVA: 180 degrees C insulation system with 115 degree C rise, encapsulated design; 15 kVA and above: minimum of 200 degree C insulation system with 115 degree C rise, ventilated design.
 - b. 1 – 75 kVA, three-phase (37.5 kVA, single-phase): 180 degrees C insulation system with 80 degree C rise, encapsulated design; 5-

45 kVA minimum of 200 degrees C insulation system with 115 degree C rise; 50 kVA and above: minimum of 220 degrees C insulation system with 115 degree C rise, ventilated design.

2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degrees C maximum ambient, and a 24-hour average ambient of 30 degrees C.

B. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade aluminum with continuous wound construction.
2. On three-phase units rated 75kVA and below and single-phase units rated 37.5kVA and below the core and coil assembly shall be completely encapsulated in a proportioned mixture of epoxy or resin and aggregate to provide a moisture proof, shock-resistant seal. The core and coil encapsulation system shall minimize the sound level.
3. On three-phase units rated 15kVA and above and single-phase units rated 15kVA and above the coils assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture; the core shall be coated with HAPs (Hazardous Air Pollutants) free water reducible electrical varnish to give good corrosion resistance. The assembly shall be installed on vibration-absorbing pads.
4. Terminals shall be welded to the leads of the coils for better conductivity, less maintenance, and lower risk of hot spots. Terminals shall not be spot welded or bolted to the coil leads.

C. Taps

1. Three-phase transformers rated 15 through 225 kVA shall be provided with six 2-1/2% taps, two above and four below rated primary voltage. Three-phase transformers rated greater than 225 kVA shall be provided with manufacturer's standard taps for that rating.
2. All single-phase transformers, and three-phase transformers rated below 15 kVA and above 500 kVA, shall be provided with the manufacturer's standard tap configuration.

D. Electrostatic Shielding

1. Where shown on the drawings, provide shielded isolation transformers with an electrostatic shield consisting of a single turn of aluminum placed

between the primary and secondary winding and grounded to the housing of the transformer.

- a. Electrostatic shield shall provide primary to secondary winding capacitance between 24 and 18 picofarads over the range of 100 Hz to 20 kHz.
 - b. Electrostatic shielding shall provide the following minimum attenuation when tested per MIL-Std-220A, Method of Insertion Loss Measurement, with matched impedance no load technique:
2. Common mode noise attenuation: Minus 80 dBA minimum at 0.1 kHz to 1.5 kHz; minus 55 dBA minimum at 1.51 kHz to 100 kHz. Normal mode (Transverse mode) noise attenuation: Minus 35dBA minimum at 1.5 kHz to 10 kHz.

E. Motor Drive Isolation

1. Where shown on the drawings, provide motor drive isolation transformers.
2. Motor drive isolation transformers shall be designed for use with three-phase ac adjustable frequency drives 600 volts and below to provide isolation between the incoming line and drive circuitry. These drives minimize the line disturbances caused by SCR firing within the drive unit. Thermoguards shall be included in all motor drive isolation transformers to provide additional protection for the transformer from increased heating due to the non-sinusoidal characteristics of drive currents. The transformer shall provide reduced short-circuit currents and voltage line transients. The transformer shall be specifically sized to the drive kVA requirements dictated by the horsepower of the motor and, as such, will be mechanically braced to withstand the stress of current reversals and short-circuit currents associated with the specific drive kVA rating.

2.04 WIRING/TERMINATIONS

- A. Recommended external cable shall be rated 90 degrees C (sized at 75 degrees C ampacity) for encapsulated and 75 degrees C for ventilated designs. Connectors should be selected on the basis of the type and cable size used to wire the specific transformer.

2.05 ENCLOSURE

- A. The enclosure shall be made of heavy-gauge steel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees C per UL requirement. The core of the transformer shall be grounded to the enclosure.
- B. On three-phase units rated 75kVA and below and single-phase units rated 37.5kVA and below the enclosure construction shall be encapsulated, totally

enclosed, non-ventilated, NEMA rating as defined on drawings, with lifting provisions.

- C. On three-phase units rated 15kVA and above and single-phase units rated 15kVA and above the enclosure construction shall be ventilated, NEMA 2, drip-proof, with lifting provisions. All ventilation openings shall be protected against falling dirt. On outdoor units, provide weathershields over ventilated openings.
- D. Ventilated type transformers that meet 10 CFR Part 431 efficiency requirements, with a core size of 150 kVA or less, shall be suitable for installation with 2-inch clearance from a wall or other obstruction behind the transformer enclosure.

2.06 FINISH

- A. Steel enclosures shall be finished with ANSI 61 color, weather-resistant enamel. Stainless steel enclosures shall not be painted.

2.07 OPTIONAL ACCESSORIES

- A. On ventilated outdoor units provide suitable weathershields over ventilation openings.
- B. Lug kits shall be provided by the Manufacturer of the transformer.
- C. Provide hinged, padlockable front cover to facilitate visual inspection and infrared scanning.
- D. Provide infrared viewing windows of size and quantity to scan the terminals of the transformer.

PART 3 - EXECUTION

3.01 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of ANSI and NEMA standards.
 - 1. Ratio tests at the rated voltage connection and at all tap connections
 - 2. Polarity and phase relation tests on the rated voltage connection
 - 3. Applied potential tests
 - 4. Induced potential test
 - 5. No-load and excitation current at rated voltage on the rated voltage connection

3.02 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

3.03 FIELD ADJUSTMENTS

- A. Adjust taps to deliver appropriate secondary voltage.

3.04 FIELD TESTING

- A. Measure primary and secondary voltages for proper tap settings.

END OF SECTION 26 22 13

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.01 SUMMARY

1.02 QUALITY ASSURANCE

A. NEMA PB-1

B. UL 67

1.03 SUBMITTALS

A. For each panelboard: amperage and phase of main bus, amperage of main circuit breaker, wire size and quantity of main lugs, grounding bar location, neutral bar location, quantity, arrangement and amperage of branch circuit breakers, quantity of spaces, physical dimension of enclosure, weight, directory card location and type, type of lock, flush or surface cover, short circuit withstand rating in RMS amperes.

1.04 DELIVERY, STORAGE AND HANDLING

A. Protect equipment from exposure to elements and keep all items thoroughly dry .

B. Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage.

1.05 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's instructions in accordance with Specification Section 01 78 23 - Operation and Maintenance Data for maintenance, including cleaning, tightening conductor connections, testing, and addition or replacement of circuit breakers.

PART 2 - PRODUCTS

2.01 LIGHTING AND APPLIANCE PANELS (UL 67)

A. Ratings

B. Construction

1. Install in a NEMA type 1 surface mount enclosure, unless indicated otherwise. Provide a hinged-front breaker access door and a separate hinged front cover (two separate hinges) for access without completely removing front panelboard cover.

2. Install common trip multipole circuit breakers. Handle ties are not permitted.
3. Circuit breakers shall have a trip indication different from the "off" or "on" position.
4. Provide wiring space according to NEC Section 312.6.
5. Provide wall mount panels with a hinged door with lock. Key locks alike. Covers shall be square with surface not extending past edges of panelboard where wall mounted.
6. Provide distributed phase bussing.
7. Metal framed circuit directory and card with plastic covering located on the inside.
8. Tin-plated copper bussing, SPD protection and additional requirements as noted on Panelboard Schedule on Drawings.

2.02 DISTRIBUTION OR "HIGH" PANELS (277/480V OR 480V) (400A OR LESS)

- A. Smaller, 3 phase mechanical and process equipment loads and 277V lighting systems utilize distribution panels (denoted by DP or H prefix) for 480 volt or 277/480V, 3 phase operation as indicated on the Drawings. Install bolt-on, thermal magnetic circuit breakers with a minimum interrupting rating of 22,000 amperes R.M.S. (minimum) unless noted otherwise on Drawings.
- B. Circuit breakers shall have a trip indication different from the "off" or "on" position.
- C. Install common trip multi-pole circuit breakers. Handle ties are not permitted.
- D. Full cabinet height bussing includes active, spare and blank breaker locations with sizes, branches, mounting, main circuit breakers, etc., as shown in Schedule on the Drawings.
- E. Provide adequate wiring space according to the National Electrical Code.
- F. Provide surface mount panels with a flush hinged door with lock. Key locks alike.
- G. Isolated neutral bar and ground bar in panelboards where indicated.
- H. Provide distributed phase bussing.
- I. Metal framed circuit directory and card with plastic covering located on the inside.
- J. Tin-plated copper bussing, SPD protection and additional requirements as noted on Panelboard "DP" Schedule on Drawings.

2.03 DISTRIBUTION OR "HIGH" PANEL (277/480V OR 480V) (OVER 400A)

- A. Basis of Design: Schneider Electric; Square D I-Line Panelboard; www.se.com.

- B. Provide distribution panel with ratings listed for 'EB-DP1' as shown within Drawings.
- C. Provide fully rated plated copper bussing.
- D. Isolated neutral bar and ground bar in panelboards where indicated.
- E. Circuit breakers shall have a trip indication different from the "off" or "on" position.
- F. Provide adequate wiring space according to the National Electrical Code.
- G. Provide distributed phase bussing.
- H. Metal framed circuit directory and card with plastic covering located on the inside.

2.04 MANUFACTURERS

- A. Lighting and Appliance Panels (L Prefix):
 - 1. Square D Type NQ
 - 2. General Electric equal
 - 3. Siemens equal
 - 4. ABB
 - 5. Cutler Hammer equal
- B. 480V Small Distribution Panels (DP or H Prefix):
 - 1. Square D Type NF
 - 2. General Electric equal
 - 3. Siemens equal
 - 4. Cutler Hammer equal
- C. 480V Large Distribution Panels (DP or H Prefix):
 - 1. Square D Type I-Line
 - 2. General Electric equal
 - 3. Siemens equal
 - 4. Cutler Hammer equal

2.05 CABLE TIES

- A. Thomas and Betts "TY-RAP"

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Type circuit directory with spare positions left blank. Hand lettering not acceptable.

- B. Neatly dress conductors and bundle with nylon cable ties.
- C. Install SPD as recommended by the manufacturer at each project panelboard. Install with leads as short as possible so that SPD indicating lights are visible.
- D. Fabricate and install bent aluminum or stainless steel formed skirt underneath panelboards to conceal cast in place conduits from floor below as indicated on the drawings. Skirt enclosure may be used as a junction box extension from the panelboard above, and conduits from below need not extend continuously through the skirt all the way to the panelboard. See details on the Drawings.

END OF SECTION 26 24 16

SECTION 26 24 19
MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.01 SUMMARY

SCOPE OF WORK TO BE CONFIRMED DURING CONSTRUCTION. INTENDED SCOPE OF WORK IS MODIFICATION OF EXISTING MCC BUCKETS AND MCC SECTION AS SHOWN WITHIN DRAWINGS. EXISTING MCC IS ALLEN-BRADLEY CENTERLINE 2100 SERIES. THE FOLLOWING SPEC SECTION IS INCLUDED ONLY AS REFERENCE FOR STANDARD MCC EQUIPMENT REQUIREMENTS. PROVIDE MCC MODIFICATIONS AS REQUIRED PER MANUFACTURER RECOMMENDATIONS. NOTE, THE HARDWARE SYSTEM INTEGRATOR AS SPECIFIED IN SECTION 40 61 13 - Process Control System General Requirements SHALL PROVIDE THE EQUIPMENT AS STATED HEREIN.

A. Section Includes:

1. Furnish and install motor control centers complete with starters and control accessories as shown on the Drawings. It is the intent of this Specification that all project MCC equipment be provided and integrated into the project, complete with NEMA Class IIS, Type B wiring/interconnection diagrams by the Hardware System Integrator specified in Section 40 61 13 - Process Control System General Requirements.
2. Motor control centers shall include all motor starters, circuit breakers, panelboards, transformers, electronic soft starters, power monitors, power supplies, variable frequency drives and related equipment as indicated on the Drawings.

1.02 DESCRIPTION OF SYSTEM

- A. Factory assembled, metal enclosed motor control center for distribution and control of power from incoming line terminals to motors installed and tested in place. Complete assembly includes starters and controls. Type II-B construction complete with Type II-B wiring diagrams provided by the Hardware System Integrator specified in Section 40 61 13 - Process Control System General Requirements. All units shall be interwired and tested as a Class IIS MCC.
- B. Each motor starter, VFD, soft starter, power monitor, and related device shall be supplied with a means to communicate all I/O via Allen Bradley Ethernet I/P and shall have the capability of monitoring at least 4 discrete input points and 2 discrete output point, minimum, or as otherwise indicated on the Drawings. Provide additional I/O cards as required to match required I/O on the drawings.

- C. All motor control center equipment shall be installed within the MCC enclosures, and the enclosures shall fit within the spaces designated and as shown on the Drawings. Contractor/Supplier shall confirm that adequate building space exists for the Supplier's proposed equipment.

1.03 QUALITY ASSURANCE

- A. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC)
- B. National Electrical Manufacturer's Association (NEMA)
 - 1. NEMA ICS 1 General Standards for Industrial Control and Systems
 - 2. NEMA ICS 2 Industrial Control Devices, Controllers and Assemblies
 - 3. NEMA 250 Enclosures for Electrical Equipment
 - 4. NEMA CP-1 Capacitors
- C. Underwriter's Laboratories (UL)
 - 1. UL 845 Electric Motor Control Centers

1.04 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures including, at a minimum:
- B. Clearly indicate concrete pad dimensions, conduit entrance area, electrical ratings, nameplate nomenclature, single line diagrams, bus bar size and type, switch amperage and location, short circuit withstand rating, starter controls, starter type and location, schematic wiring diagrams for starters.
- C. Submit schematics and wiring diagrams for each starter, VFD, and related device provided in the motor control center.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Lift motor control center using eyes, yokes, and skids provided by manufacturer.
- B. Store motor control center in a dry area, protected from the weather.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's instructions in accordance with Specification Section 01 78 23 - Operation and Maintenance Data for tightening bus connections, performing cleaning, operating and maintaining motor control center, repair parts list.

- B. Submit "asbuilt" schematic and wiring diagrams for each device installed in the motor control center.

PART 2 - PRODUCTS

2.01 MOTOR CONTROL CENTER

A. Type and General Requirements:

1. Class II, Type B, NEMA 1, gasketed.
2. Total enclosed freestanding.
3. Arrangement of starters, VFDs and related equipment as shown on the Drawings.
4. Engraved nameplate identification.
5. Tin-plated copper bussing (ratings as shown on the Drawings).
6. Voltage as shown on the Drawings.
7. Equipment ground bus (full length of enclosure). Neutral bar where required and/or indicated on the Drawings.
8. Standard finish.
9. Design individual sections for bolting together at installation site.
10. Horizontal neutral plate.
11. Short circuit withstand rating as shown on the Drawings.
12. Circuit breaker disconnect (magnetic) for each starter. Thermal magnetic circuit breakers for all feeders.
13. For all 3 phase non-VFD driven motors, provide factory wired single phasing protection using electronic overload relays that are suitable for providing single phasing protection.
14. Additional feeder/distribution circuit breakers per MCC Schedules on Drawings.
15. Additional requirements per MCC Schedules, Onelines and Details on Drawings.

- B. Motor control centers shall be of the indoor type, with Class II Type B construction in accordance with the applicable NEMA standards. The motor control centers shall be factory assembled with combination starters, and other components and equipment as shown. The proposed motor control center layouts shall be approved by the Engineer. It is the intent that components and systems identified on motor control center one line diagrams and schematic diagrams be furnished by the manufacturer of the motor control center. Motor control centers shall bear the U.L. label and shall bear a U.L. "suitable for use as service entrance equipment" label as noted on the drawings.

C. Ratings

1. The rating of the motor control centers shall be as follows:
 - a. Voltage: 277/480 Volts

- b. Frequency: 60 Hz
 - c. Phases: 3
 - d. Control Voltage: 120 VAC
 - 2. The current capacity of the horizontal main bus shall be as shown on the drawings and the current capacity of the vertical riser bus shall be 300 amps minimum or as required for the application. The momentary capacity of the bus shall not be less than as shown on the One-line Diagrams.
- D. The motor control center shall be of the unitized metal enclosed type with NEMA Type 1 enclosure. Sections shall be nominally 90 inches high, 20 inches wide and 20 inches deep, joined together to form a rigid, free standing completely deadfront assembly. The motor control centers shall be of Class II Type B construction in accordance with the applicable NEMA standards. The motor control centers shall be arranged and bussed to accommodate removable units and so that units may be mounted front only. Doors and access panels shall be flanged with the corners welded and ground smooth. All metal parts of the frame and all panels shall be painted on all sides. Each section shall be for not more than 6-1/2 space factor utilization. All components shall be mounted inside starter or auxiliary compartments except elapsed time meters, ammeters, switches, and pilot lights which shall be flush mounted in the appropriate cubicle with the devices labeled.
- E. A continuous tin-plated copper ground bus bar at least 1/4 inch x 2 inches in size shall be provided in a conveniently accessible location. The ground bus shall be provided with solderless lugs for No. 2/0 AWG to No. 4/0 AWG cable for attachment to the ground grid as indicated on the Drawings.
- F. Doors and access panels shall be flanged with the corners welded and ground smooth. Sheet metal for each panel shall be not less than .056 inch thick when the panel is not larger than 360 square inches; .067 inch thick when the panel is not larger than 1,000 square inches; and .097 inch thick when the panel is larger than 1,000 inches square. Access panels shall have one fastening device not more than six inches from each of the four corners and fastening devices not more than 24 inches apart along vertical side. Any panel having dimensions not exceeding six inches high may be fastened by two fastening devices, one at the center of each of two opposite sides. Doors shall be secured with not less than two hinges. Hinges shall be located not more than four inches from each end of a door and shall be spaced not more than 24 inches apart. Each leaf of each hinge shall be fastened at not less than two points to the door, and not less than two points to the structure. Each hinged door shall be capable of supporting not less than four times its own weight and not less than thirty pounds without causing permanent deformation to the hinges. Doors shall be provided with snap latches or captive screws. Doors more than 48 inches long shall be fastened with a two point or three-point latch.

- G. Each vertical section shall be furnished complete with a 3-phase main horizontal bus. Power shall be distributed to units in the vertical sections by means of a 3-phase vertical bus. Buses shall be silver plated at all contact points or tin plated on aluminum bus. Bus supports shall be high dielectric strength, with low moisture absorption. All bus work shall be suitably braced to withstand short circuit currents as specified. A full height insulating barrier shall be provided for isolation of the vertical bus from the units. Guide rails or other means shall be provided in the structure for supporting and aligning starter units during removal or replacement. All units shall be easily removable and shall be connected to the vertical bus by means of self-aligning stab on bus connectors of low resistance arranged for positive contact with both sides of the bus at all times or by bolting on the larger sizes. A horizontal wiring and bus compartment shall be provided at the top and bottom. In addition, each section shall have a vertical wiring space equipped with cable tie supports for unit wiring. Bus bars shall be sized such that their temperature rise does not exceed 50 deg. C.
- H. Main Circuit Breaker and Branch Circuit Breaker Protection
1. Branch circuits served by motor control centers for devices other than motors shall use circuit breakers or fused switches as required.
 2. Circuit breakers shall include both instantaneous and long time trip elements.
 3. Circuit breakers shall have an interrupting rating equal to the bracing of the bus bars unless indicated otherwise.
 4. Fused switches shall include dual element fuses with a rating as required for the application. Fuses shall be manufactured by Buss, Littelfuse, or equal.
- I. Control Relays
1. Control Relays shall be quiet in operation and shall not have less than four contacts. Relays shall be enclosed in NEMA 1 enclosures and shall be mounted such that they may be removed and installed from the front. Installations where the bus bar compartment must be opened to remove nuts, etc., from mounting screws is not acceptable. Relay operating coils, contacts, etc., shall be designed for continuous operation in atmospheres up to 65 deg. C. Control relay compartments shall be convection cooled. Forced air cooling is not acceptable.
 2. General control relays shall be plugin type with sockets. The relays shall have dust covers, suitable for continuous operation, and shall be rated for not less than 10 amps at 120 VAC, 1.0 PF. The contacts shall be 3/16" diameter silver cadmium oxide, min.
- J. Elapsed time meters shall have a minimum of 5 digits and shall read in hours and tenths of hours. Meters shall be nominal 3" diameter with 1/8" high numerals.

- K. Nameplates shall be supplied to identify each motor control center compartment and shall be of the laminated black and white composition type with black face and with engraving extending into the white to give white letters on a black background. Nameplates shall be 3 inches long by 1 inch high with 1/8-inch-high lettering. Nameplate for switches, relays and other accessories shall have 1/8-inch-high lettering and shall be sized as required. Nameplates shall be fastened with screws; adhesives only are not acceptable.
- L. All control devices including, but not limited to, selector switches, pushbutton switches, limit switches and indicating lights shall be of the 30mm heavy duty, oil tight type. The contacts shall meet NEMA rating designation A600. All time clocks, timers, switches, relays, etc., shall be permanently labeled.
- M. Control wiring shall be copper, 90 deg C minimum and shall not be smaller than #14 AWG. All wiring for external connection shall be terminated on fabricated terminal blocks with lettering strips. All termination strips shall correspond with points called out on shop drawings and field connection diagrams.
- N. Surge Protection
 - 1. Provide a SPD in the MCC where indicated on the drawings. SPD shall meet requirements as specified Section 26 43 00 - Surge Protective Devices.
- O. Variable Frequency Drives (VFDs) and VFD Output Circuitry Requirements
 - 1. Provide VFDs in MCC construction where indicated on the Drawings. VFDs shall be provided per the requirements of Section 26 29 23 - Variable Frequency Motor Controllers.
 - 2. Special care shall be used by the MCC manufacturer and installer to ensure that the output conductors of each VFD are not installed in common MCC wireway or otherwise close proximity with other conductors such that excessive noise and/or crosstalk could create erratic or otherwise unacceptable operation of the VFDs installed within the MCC.
 - 3. Special care shall include, but shall not be limited to the following:
 - a. Install VFDs such that there is only 1 VFD per vertical section, or VFDs installed only at the top or bottom of a vertical section, each with a dedicated wireway, cast in place conduit or other direct conduit exit out of the compartment for the associated VFD output conductors.
 - b. Install all VFD output conductors in metallic flex conduit throughout the interior of the MCC if they cannot be isolated from other conductors as described above.
 - c. Utilize shielded VFD cable for VFD output circuits where indicated in the cable and conduit schedule.
 - d. Maintain 6" minimum separation (8" or greater separation, if possible) between exposed VFD output circuits and other exposed

circuitry and do not install VFD output circuits in parallel with other circuits for distances over 10 feet.

- P. It shall be the full responsibility of the MCC Supplier in conjunction with the Contractor to design, install and otherwise provide a fully functioning MCC system with integrated VFDs that do not interfere or are otherwise affected by interference from other cabling system and components installed within the same MCC. As such, the Supplier and Contractor shall take all means necessary and as described to ensure that satisfactory VFD operation for all MCC mounted VFDs is realized for the project.
- Q. All such fabrication and installation costs for adequately shielding and isolating every set of VFD output conductors installed within MCC construction shall be included in the Contractor's Bid Price for the Work.
- R. CONTROL DEVICES
 - 1. Where required the Contractor shall supply all control devices including, but not limited to, selector switches, push button switches, limit switches, and indicating lights. All control devices shall be of the heavy duty, oil tight type. The contacts shall meet NEMA rating designation A600. Each control device shall be supplied complete with escutcheon and nameplate. Each control device shall have its function permanently marked on the escutcheon. Raised letters on plastic adhesive tape is not acceptable.
 - 2. Furnish and install engraved plastic type label designating equipment served. Embossed raised letter type labels shall not be acceptable. Letters shall be 1/4" high and white in color on a black background.
- S. Manufacturers:
 - 1. Allen Bradley
 - 2. Cutler Hammer
 - 3. Square-D
 - 4. ABB
 - 5. Prior approved equal

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Examine area to receive motor control center to assure adequate clearance for installation.
- B. Check that existing concrete pads are level and free of irregularities.
- C. Verify exact dimensions with supplier prior to conduit rough-in.

- D. Install motor control center in accordance with manufacturer's instruction.
- E. Field test prior to energization:
 - 1. Megger checks of phase to phase and phase to ground insulation levels.
 - 2. Continuity.
 - 3. Short circuit.
- F. Perform tests according to manufacturer's instruction.
- G. Adjust operating mechanisms for free mechanical movement.
- H. Tighten bus connections and mechanical fasteners.
- I. Touchup scratched or marred surfaces to match original finish.

3.02 TRAINING

- A. Training on the motor control center(s), included MCC mounted VFDs, soft starter and related equipment shall be for two (2) hours, minimum. Training shall consist of one (1) 2-hour sessions at the Site.
- B. All training sessions shall be at times prior approved by the Owner. Two weeks prior notice shall be given in writing for all training sessions.

3.03 SUPPLIES

- A. At Final Completion, Contractor shall furnish the following expendable items:
 - 1. Five (5) percent spare fuses and lamps of each type furnished under this Section, but not less than three (3) of each type.

END OF SECTION 26 24 19

SECTION 26 27 19
TRANSITION CABINET

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnish and install a pad mount transition cabinet including connections to service transformer where indicated on the drawings.

1.02 WORK INSTALLED BUT FURNISHED BY OTHERS

- A. Utility Company will provide the pad mounted service transformer and transformer related lugs and terminations. Electrical Contractor shall provide all electrical terminations and required lugs related to the Transition Cabinet.
- B. Utility Company will provide current transformers and all associated metering terminations. Verify exact current transformer cabinet requirements with the Utility Company before installation.

1.03 QUALITY ASSURANCE

- A. U.L. listed

1.04 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures including, at a minimum:
- B. Cabinet dimensions, bussing arrangement, short circuit, withstand rating, cable mounting hole arrangement in bus.

PART 2 - PRODUCTS

2.01 TRANSITION CABINETS

- A. Manufacturer: States Electric, American Midwest Products (AMP), Electro Mechanical Industries (EMI) or approved equal.
 1. Pad mounted Nema 3R enclosure.
 2. Enclosure primed and painted transformer green.
 3. 277/480 Volt, 3 Phase, 4 Wire, Wye.
 4. 85,000 AIC
 5. Tin plated aluminum bussing with ampacity as noted on the Drawings.
 6. Split bussing for either C.T. or inline metering per Utility Company's requirements.

7. Complete with all mounting hardware.
8. Properly sized lugs per phase and neutral as required.
9. Used for entire plant metering.

PART 3 - EXECUTION

3.01 GENERAL

- A. Verify transition cabinet location and installation with the Utility Company.
- B. Make all electrical connections as shown on the Drawings.
- C. Ensure that the transition cabinet is securely mounted and completely weatherproof.

END OF SECTION 26 27 19

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnish and install all wiring devices and device plates where shown on the Drawings.

1.02 WORK INSTALLED BUT FURNISHED BY OTHERS

- A. Where indicated, install devices supplied by Division 1 through 40.

1.03 QUALITY ASSURANCE

- A. NEMA
- B. U.L. Listed
- C. NFPA 70 - National Electrical Code, current adopted Edition

1.04 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures. Clearly indicate device type, voltage, amperage, NEMA configuration, color.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Store in a dry area, protected from the weather.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit in accordance with Specification Section 01 78 23 - Operation and Maintenance Data, a list of all devices used, including manufacturer and type.

PART 2 - PRODUCTS

2.01 DUPLEX RECEPTACLES: (SURFACE MOUNTED IN FINISHED AREAS)

- A. Manufacturer: Equal to Hubbell #5352 Series, Bryant #5352, Leviton #5352, P&S CR Series, or P&S #5362 Series duplex.
- B. Type:
1. Specification grade
 2. Gray in color (normal applications); Blue for UPS applications.

3. 20 Ampere
4. 120 Volt
5. 3 Wire Grounding

2.02 GROUND FAULT RECEPTACLE

A. Manufacturer: Equal to P&S 1597 Series, Eaton SGF15, Leviton:

1. 15 A Capacity
2. Gray
3. 120 Volt with 5 milliampere trip

B. Manufacturer: Equal to P&S 2097 Series, Eaton SGF20, Leviton:

1. 20 A Capacity
2. Gray
3. 120 Volt with 5 milliampere trip

C. Other Manufacturers and models must be approved by Engineer

2.03 TOGGLE SWITCHES

A. Manufacturer: Equal to P & S #20AC, Eagle 2221

B. Type:

1. Specification grade
2. Gray in color
3. 20 Ampere
4. 120/277 Volt
5. Quiet operation, keyed switch where indicated, single pole unless noted otherwise.

2.04 PILOT LIGHTED SWITCHES

A. Manufacturer: Equal to P & S #20AC1-RPL, Eagle 2221PL

B. Type:

1. Red in color
2. 20 Ampere
3. 120/277 Volt
4. Quiet operation

C. Neon type that is illuminated when switch is in the "on" position

D. Specification grade

2.05 PILOT LIGHTS

A. Manufacturer: Equal to Arrow Hart

B. Type:

1. Neon with red jewel

2.06 DEVICE PLATES

A. Provide device wall plates per Specification Section 26 05 37 - Boxes and as required by NEC.

2.07 WEATHERPROOF COVERS

A. Provide weatherproof device covers on all exterior devices, wet area devices, chemical room devices and in other areas indicated on the Drawings and as required by the NEC.

B. Unless indicated otherwise, covers shall be of the "weather protected while in use" variety and shall consist of the following:

1. Exterior Applications: cast aluminum, lockable, sized as required for the application. Manufacturer/Model: Intermatic / Type #WP10, or equal.
2. Wet, Chemical or Caustic Interior Areas: clear plastic or PVC construction, Carlon, Intermatic WP5100 Series, or equal.

2.08 CLASS I, DIVISION I, GROUP D OR CLASS I, DIVISION 2, GROUP D AREAS

A. All devices shown on Drawings to be located in areas that are noted as Class I, Division 1, Group D or Class I, Division 2, Group D shall be UL listed for use in the respective classified areas. Specifically, all electrical within Odor and Corrosion Control room and within Wet Wells shall be Explosion proof and wired per NEC 500 and NEC 501.

B. Toggle Switches:

1. Manufacturer: Appleton EDS Series or equal by Crouse Hinds or Killark.
2. Type:
 - a. 20 Ampere
 - b. 120/277 VAC
 - c. Self-sealing, or provide listed seal offs
 - d. Class I, Div. 2, Groups B,C,D

C. Ground Fault Receptacles:

1. Manufacturer: Killark UGFI20C2 or equal Ark-Gard by Crouse Hinds, or U-Line by Appleton.
2. Type:
 - a. GFCI protected
 - b. 20 Ampere

- c. Class I, Div. 2, Groups B,C,D

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install devices and device plates where shown on the Drawings.
- B. All receptacles and switches listed within this section shall be installed with the ground side down.
- C. Provide blank plates for unused openings.
- D. See Section 26 05 53 - Identification for Electrical Systems for engraving requirements for pilot lights and pilot lighted switches.

3.02 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, and other foreign material and restore to match original factory finish.

3.03 PROTECTION

- A. Protect installed products from subsequent construction operations.

END OF SECTION 26 27 26

SECTION 26 28 13
FUSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Fuses for fuse holders except where equipment is noted "spare".

1.02 QUALITY ASSURANCE

- A. UL listed

1.03 DELIVERY, STORAGE AND HANDLING

- A. Store in a dry area, protected from the weather.

PART 2 - PRODUCTS

2.01 FUSES

- A. Manufacturer: Bussman Manufacturing, Gould/Shawmut.
- B. 600 amperes and larger, Class L
 - 1. Buss KRP-C or Gould A4BQ.
- C. Less than 600 amperes, Class J
 - 1. Buss LPJ or Gould AJT
- D. Motor branch circuit protection, less than 600 amperes, Class J, with time delay characteristics
 - 1. Buss LPJ or Gould AJT
- E. Selectivity
 - 1. Where indicated, furnish products as required to achieve selective coordination.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide fuses for fuse holders in equipment.
- B. Install fuses with label oriented outward such that manufacturer, type, and size are easily read.

- C. Supply to the Owner one spare fuse for each fuse installed of 400 ampere or larger rating.
- D. Supply to the Owner, below 400 ampere, one spare fuse for each three fuses of each ampere and class rating installed with a minimum of three spares for each ampere rating and class rating used.

END OF SECTION 26 28 13

SECTION 26 28 18
ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Disconnects for motors and equipment as required by National Electrical Code, for personnel protection, and for electrical isolation of equipment.

1.02 QUALITY ASSURANCE

- A. U.L. Listed, heavy duty type.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Store in a dry area, protected from the weather.

PART 2 - PRODUCTS

2.01 DISCONNECTS

A. General Requirements

- 1. Heavy duty type, horsepower rated
- 2. Quick make, quick break operation
- 3. Non fused, unless noted fused on the Drawings.
- 4. 250 VAC or 600 VAC as required per the load they serve.

B. Type

- 1. NEMA 12 for disconnects located in controlled atmosphere, general areas, unless indicated otherwise. NEMA 12 shall be considered the default enclosure rating for interior disconnects in non-caustic, wet or corrosive areas, unless indicated otherwise.
- 2. NEMA 4X for disconnects located in wet, caustic or corrosive areas, unless indicated otherwise. The disconnects shall be stainless steel or non-metallic as defined on the Drawings.
- 3. NEMA 3R for disconnects located outside building or subject to damp or wet areas, unless specifically noted otherwise.
- 4. NEMA 7 Explosion proof (listed for use in Class I, Division 1, Group D or Class I, Division 2, Group D classified areas as noted on the Drawings) where required.
- 5. Rotary type Disconnects: Compact, heavy duty, NEMA 4X, metallic or non-metallic case, rotary type disconnect switches may be used for smaller HVAC and process loads (such as electric valve actuators,

condensing units, fans, etc.) and shall be of the fused or non-fused type as indicated on the Drawings.

6. Where indicated on the Drawings, provide disconnect switches used on VFD outputs with an auxiliary contact that opens prior to the respective "phase" contacts. The auxiliary contact shall be wired to the respective "enable input" of the VFD to shut down and disable the VFD prior to the phase conductor's opening.
7. Square-D
8. Cutler Hammer
9. Siemens
10. General Electric

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Securely mount safety switches plumb and level.
- B. Comply with accessibility, clearance and mounting height requirements as listed in the National Electrical Code.
- C. Tighten conductor connections according to manufacturer's recommendations.

3.02 CLEANING

- A. Clean dirt and debris from switch enclosure and components according to manufacturer's instruction.
- B. Repair scratched or damaged exterior surface to original factory finish.

END OF SECTION 26 28 18

SECTION 26 29 13
ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Motor starters furnished and installed within the MCC or their respective control panel by Division 26, unless noted otherwise on the Schedules included with the Drawings.

1.02 QUALITY ASSURANCE

- A. NEMA UL listed

PART 2 - PRODUCTS

2.01 MOTOR STARTERS

- A. Full Voltage Non Reversing (FVNR)
 - 1. Across-the-line, full voltage, non-reversing, magnetic type, NEMA Size 1 minimum, unless noted otherwise.
 - 2. Mounted within MCC enclosure or separately mounted as noted on the Drawings.
 - 3. Control circuit as determined by the Hardware System Integrator.
 - 4. Fused control circuit transformer.
 - 5. Hand-Off-Auto selector switch, green (or red) "Run" indicating light as indicated on the Drawings, and red "Fail" indicating light where indicated on the Drawings. Other specific control switch/indicating light configurations as indicated on the Drawings shall be provided.
 - 6. Minimum of two normally open auxiliary contacts.
 - 7. Three resettable, ambient compensated thermal overload devices (one per phase). Electronic overload relays shall be considered acceptable for this requirement.
 - 8. Elapsed time meter.
 - 9. Single phase protection shall be provided either by the electronic overload relay or separate power monitor device.
 - 10. NEMA rated.
 - 11. All pilot lights, push buttons and control accessories shall be 30 mm, NEMA 4, oil tight and shall be installed on front cover of each respective MCC bucket or starter enclosure front door. Each device shall carry the A600 designation.
 - 12. Utilize combination circuit breaker type starters.
 - 13. Separately mounted starters that are required shall be provided in NEMA type 12 enclosures or as otherwise indicated.

14. Provide starters with overload elements or overload relay setting ranges equal to or greater than the nameplate rating on the installed motor.
15. Ethernet I/P Communication Port
 - a. Provide starter with Ethernet I/P communication capability as indicated on the Drawings. Furnish and install appropriate Ethernet I/P communication module with the starter.
16. Schedule of Equipment
 - a. See Drawings.
17. Manufacturers:
 - a. Allen Bradley
 - b. Cutler Hammer
 - c. General Electric
 - d. Square-D
 - e. Siemens

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Starters shall be installed within the indicated location.
- B. Provide starters with overload elements or overload relay setting ranges equal to or greater than the nameplate rating on the installed motor.
- C. Terminate motor lead connections.
- D. Coordinate and provide interconnects between MCC starters and control panels. Provide complete labeled wiring diagram showing connections.

3.02 SUPPLIES AND SPARE PARTS

- A. At Substantial Completion, furnish the following expendable items:
 1. 20% spare fuses and lamps of each type furnished , but not less than six (6) of each type.
 2. Complete set of overload heater elements of each size installed, or if electronic overload relays are utilized, provide a spare electronic overload relay of each size installed.

END OF SECTION 26 29 13

SECTION 26 29 23
VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. **The site elevation is approximately 5000 feet above sea level. All equipment as noted within the Contract Documents shall carry a rating as indicated at this noted site elevation. The equipment manufacturers shall be responsible for applying all necessary altitude de-rating factors.**
2. Furnish and install adjustable frequency drive controllers (VFDs) for all motors as shown on the Drawings.
3. Supply of VFDs in the following applications as indicated on the Drawings:
 - a. 6-pulse VFDs:
 - 1) VFD input circuitry (each VFD) shall include series line reactors or DC chokes (3% to 5% nominal as recommended by the VFD Supplier) and 6 pulse rectifier circuitry, standard so that input voltage characteristics shall have total harmonic distortion (THD) through the twenty fifth (25th) harmonic of not more than 3% per IEEE Standard 519.
 - b. MCC Mounted VFDs:
 - 1) 6-pulse VFD with line reactors
4. Provide local control devices as indicated on the Drawings.
5. Provide VFD output dV/dT filters as indicated on the Drawings.
6. Provide local disconnect switches with auxiliary contact as indicated on the Drawings.
7. It is the intent of this Specification that the project VFDs be provided with Type II-B wiring diagrams and fully integrated into the project control system by the Hardware System Integrator specified in Section 40 61 13 - Process Control System General Requirements

1.02 QUALITY ASSURANCE

A. NEMA U.L. Listed

1. UL 508C Motor Drives
 - a. Applies to drives designed prior to 2016 only
2. UL 61800-5-1 Adjustable Speed Electrical Power Drive Systems
3. UL 845 Electric Motor Control Centers

- B. National Fire Protection Association (NFPA)
 - 1. NFPA 70 National Electrical Code (NEC), current adopted Edition
- C. National Electrical Manufacturer's Association (NEMA)
 - 1. NEMA ICS 1 - General Standards for Industrial Control and Systems
 - 2. NEMA ICS 2 - Industrial Control Devices, Controllers and Assemblies
 - 3. NEMA 250 - Enclosures for Electrical Equipment
 - 4. NEMA CP-1 - Capacitors

1.03 WORK FURNISHED AND INSTALLED BY OTHERS

- A. All motors provided by other Specification Sections should meet the requirements of Section 26 05 10 - Motors.
- B. VFDs shall be integrated into the control system and provided with Type II-B control drawings by the Hardware System Integrator specified in 40 61 13 - Process Control System General Requirements.

1.04 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures. Clearly indicate VFD nameplate ratings, dimensions, schematic wiring diagrams, accessories.

1.05 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's data in accordance with Section 01 78 23 - Operation and Maintenance Data for operation and maintenance data for repairing, cleaning, testing requirements and parts list.
- B. Include a VFD setting sheet that lists the final settings of each VFD as coordinated with the Contractor and the equipment supplier(s).

PART 2 - PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

- A. Variable frequency drive (VFD) unit shall be pulse width modulated (PWM) type incorporating volts per Hertz control. Unit shall bear the U.L. label. Refer to the Drawings for specific details.
- B. Input characteristics and requirements:
 - 1. 480 volt (nominal) +/- 10%, three phase, 60 Hz +/- 1.0 Hz.
 - 2. Efficiency, 97.0% at full speed, input to output; input line pf, 0.95 minimum.

3. Drive shall automatically shut down on input power abnormalities and shall automatically restart upon restoration of "normal" power.
 4. Incoming line surge protection, arresters, and surge capacitors shall be provided at a minimum.
 5. Current limiting SCR fuses shall be applied where applicable or otherwise required by VFD manufacturer.
 6. 6-Pulse VFD Input Equipment Requirements
 - a. VFD input circuitry (each VFD) shall include series line reactors (3% to 5% nominal as recommended by the VFD Supplier) and 6 pulse rectifier circuitry, standard so that input voltage characteristics shall have total harmonic distortion (THD) through the twenty fifth (25th) harmonic of not more than 3% per IEEE Standard 519-1992.
- C. Ambient conditions:
1. Temperature: 0-40°C.
 2. Humidity: 5-95% non-condensing.
- D. Output conditions:
1. 480 volt, 3 phase.
 2. Operate 480 volt, nominal 3 phase, Design B, motor with NEMA Code G locked rotor characteristics unless indicated otherwise. Size VFD for not less than motor nameplate full load ampacity. Pay particular attention to the full load amp ratings of non-NEMA motors such as submersible pumps, etc.
 3. Rated for 110% of drive amperage rating overload for one minute, minimum.
 4. Variable Torque – Standard duty VFD applications such as centrifugal fans and pumps shall be provided with variable torque VFD ratings.
 5. Constant Torque - Heavy duty VFD applications such as augers, rotary lobe pumps, mixers, etc. shall be provided with constant torque VFD ratings. See the Drawings for additional information.
 6. The Contractor shall be responsible for furnishing and installing all auxiliary equipment recommended by the drive manufacturer to prevent equipment damage and excessive noise. This auxiliary equipment shall include, but not be limited to, line reactors, shielded cable, motor terminators, dV/dT filters and increased cable insulation. Such devices shall reduce ripple in the rectifier output and reduce harmonic distortion reflected into incoming power feeders to acceptable levels. These output series devices shall also protect the motor from damaging overvoltage resulting from reflected higher order frequencies.
 7. General guidelines for VFD output accessory devices shall be as follows unless specifically otherwise noted on the one line Drawings, based on

motor lead lengths, but should be confirmed with the specific VFD manufacturer before implementation:

- a. Output Leads 50 Feet or Less: No output accessories required, unless recommended by the VFD supplier.
 - b. Output Leads 50 to 150 Feet: Provide line reactor or motor attenuator as recommended by the VFD supplier. See the Drawings for additional requirements.
 - c. Output Leads more than 150 Feet: Provide dV/dT filter
8. Maximum peak voltage of PWM VFD output pulse of 1000 volts, with pulse rise time of not greater than 2 microseconds. Maximum frequency of PWM VFD output pulse (carrier) frequency of 3000 Hz. Should magnitudes of these characteristics be more stressful to motor insulation than specified values, furnish filter network on VFD output to protect motors.
- a. Coordinate with the VFD manufacturer, which devices are required and will be supplied based on estimated motor lead lengths from the drive to the motor and VFD manufacturer recommendations. The application of filtering equipment shall be designed and approved by VFD manufacturer and built into the VFD enclosure.
 - b. As part of the shop drawing submittals, submit a VFD performance study for each VFD installation which provides documentation justifying the use of devices which show conformance to the VFD manufacturer's recommendations on motor lead lengths and other noise/motor damage prevention requirements. This study shall include anticipated peak voltage to the motor, anticipated pulse rise time, and the PWM output pulse frequency setting based on anticipated lead lengths from the drive to the motor for each installation.
 - c. Reset PWM pulse output frequency from the factory default to the lowest possible setting (2000 to 3000 Hz), nominal.
 - d. Coordinate minimum equipment rotating speed, skip frequencies and ramp rates with the process and mechanical equipment suppliers, and program the VFD accordingly.

E. Features:

1. VFD's for installation within waste water facilities or lift stations, harsh environments, or areas exposed to chemical exposure shall have circuit boards conformally coated for increased corrosion resistance protection.
2. Programmable parameters:
 - a. Acceleration time
 - b. Deceleration time
 - c. Frequency range
 - d. Skip frequency ranges
 - e. Number of restart attempts
3. Overload protection (Confirm full load rating w/motor manufacturer and program VFD to limit speed such that motor is not overloaded.)
4. Programmable displays:

- a. Frequency
- b. Voltage
- c. Percent load
- d. Percent power
- 5. Protection features (with separate indications for each event):
 - a. Undervoltage trip
 - b. Overvoltage trip
 - c. Drive overcurrent trip
 - d. Drive overtemp trip
 - e. Motor overcurrent trip
 - f. Motor overtemp trip (monitor normally closed thermal switch in motor)
 - g. Output ground fault trip

F. Front Panel Components and Control Configuration:

- 1. Ramp Up / Ramp Down Settings
 - a. Coordinate, confirm, and document all VFD settings including, but not limited to, ramp rate, minimum speed, and maximum speed with the process equipment supplier during startup. Field test and adjust all settings in cooperation with the process equipment supplier.
 - b. It is anticipated that each VFD will be set to ramp up to a pre-determined speed set at the VFD over an adjustable time period (20 seconds nominal - confirm).
 - c. It is anticipated that each VFD will ramp down upon stop command over an adjustable time period (20 seconds nominal - confirm). On pumps, the VFD should stop at approximately the same time that the pump check valve closes - if applicable. Adjust this feature to approximate time required to minimize water hammer.
 - d. Coordinate exact requirements with individual equipment suppliers and program specialty ramps (such as dual slope ramps to submersible well motors to protect the Kingsbury bearings) as required to maintain equipment warranty.
- 2. Ethernet I/P Control Module - Able to see and modify drive parameters as listed on the drawings over the Ethernet I/P network via the manufacturers Ethernet I/P communications card.

G. Enclosure

- 1. Drive and all line reactors, filters and accessory equipment shall be installed within as shown within Drawings.

H. Manufacturer/Model

All project drives furnished shall be provided from the same manufacturer

- 1. AllenBradley Powerflex
- 2. Square D equivalent
- 3. Cutler Hammer equivalent

4. ABB
5. Or prior approved equivalent.

2.02 VFD OUTPUT FILTERING

- A. Furnish and install motor dv/dt filter for use on motor cable runs exceeding 150 feet for motors with a peak voltage insulation rating less than 1600 Vac or as indicated on the drawings.
- B. It is the Contractor's responsibility to appropriately size the dV/dT filters for the connected load. The continuous ampere rating of the dV/dT filter shall be equal to or greater than the full load ampere output rating of the associated VFD at the given site elevation.
- C. dV/dT filters shall be installed in UL listed, NEMA 12 enclosures if provided outside the overall VFD enclosure or MCC bucket and shall be the responsibility of the Contractor to install and completely connect with cable and conduit at no additional cost to the Owner. The preferred method of dV/dT filter supply is for them to be provided as an integral part of the overall VFD system (internal to the overall VFD enclosure or MCC bucket). Overall assembly shall be UL listed to UL-508A.
- D. Manufacturer/Model:
 1. MTE / Series A dV/dT Filter
 2. TCI Equal
 3. Or prior approved equivalent

2.03 CONTROL DEVICES

- A. Where required the Contractor shall supply all control devices including, but not limited to, selector switches, push button switches, limit switches, and indicating lights. All control devices shall be of the heavy duty, oil tight type. The contacts shall meet NEMA rating designation A600. Each control device shall be supplied complete with escutcheon and nameplate. Each control device shall have its function permanently marked on the escutcheon. Raised letters on plastic adhesive tape is not acceptable.
- B. Furnish and install engraved plastic type label designating equipment served. Embossed raised letter type labels shall not be acceptable. Letters shall be ¼" high and white in color on a black background.
- C. Control Power Transformers (CPT) are to be installed within VFD enclosures as shown on drawings for use with control devices and accessories. CPT's are to be sized with 25% spare capacity minimum and provided with primary and secondary fused protection.

- D. See Drawings for controls layout for each VFD.

2.04 LOCAL DISCONNECT SWITCHES

- A. Where indicated on the Drawings, provide heavy duty, non-fused or fusible local disconnect switches with NEMA 1 enclosures minimum for interior applications not in wet or corrosive environments. If the disconnect switch is to be mounted outdoors or in areas subject to rain or falling water, NEMA-3R enclosure shall be provided. If the disconnect switch is to be mounted in a wet and/or caustic or corrosive environment, NEMA 4X stainless steel enclosures shall be provided. Refer to the Drawings for additional requirements.
- B. All local disconnect switches applied on VFD output circuits shall include an auxiliary contact that opens prior to the associated "phase" contacts. The auxiliary contact shall be wired to the respective "enable input" of the VFD to shutdown and disable the VFD prior to the opening of the "phase" contacts.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Provide all VFDs with variable torque or constant torque ratings as required for the driven equipment, continuous full load ampere ratings and overload settings equal to or greater than the nameplate rating on the installed motor.
- B. Utilize liquid tight conduit connections to motor as noted in Section 26 05 34 - Conduit.
- C. The Contractor (in conjunction with the process or mechanical equipment supplier and the VFD supplier) shall fully test and adjust the variable frequency drive to allow control of each system to maximum efficiency, including lockout frequencies. The final arrived at settings for each VFD system shall be submitted to the Engineer and included in the O&M manuals.

3.02 FACTORY TESTING

- A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest version of UL and NEMA standards.
 - 1. All printed circuit boards shall be functionally tested via automatic test equipment prior to unit installation.
- B. The manufacturer shall provide three (3) certified copies of complete VFD final test reports.

3.03 TRAINING

- A. Training on the project VFD's shall be for eight (8) hours, minimum on site. The training sessions shall consist of two (2) separate, four (4) hour sessions at Site. The Owner may record the training sessions.
- B. All training sessions shall be at times that are prior approved with the Owner. Two week prior approval of all training sessions is required.

3.04 SUPPLIES

- A. At Final Completion, Contractor shall furnish the following expendable items:
 - 1. Twenty (20) percent spare fuses and lamps of each type furnished under this Section, but not less than two (2) of each type.
 - 2. The following spare parts shall be provided:
 - a. Main Control Board - One (1) per VFD Frame size on the project to which they are compatible with.
 - b. HIM - One (1) of each type provided on the project
 - c. Communication Card - One (1) per VFD Frame size to which they are compatible with.
 - d. Fans - One (1) per VFD Frame size provided on the project to which they are compatible with.
 - e. I/O Cards - One (1) of each type provided on the project.

END OF SECTION 26 29 23

SECTION 26 32 13
ENGINE GENERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. **The site elevation is approximately 5000 feet above sea level. All equipment as noted within the Contract Documents shall carry a rating as indicated at this noted site elevation. The equipment manufacturers shall be responsible for applying all necessary altitude de-rating factors.**
2. Furnish and install a complete engine generator set, fully assembled as indicated on the Drawings, tested and ready to operate including fuel supply, exhaust system and cooling equipment. Both engine and generator shall be the responsibility of a single manufacturer and be of a standard model or series in regular production at the manufacturer's place of business. No unit assembled by anyone other than a recognized manufacturer will be accepted.

GENERATOR SIZE (MINIMUM):	400 kW
GENERATOR EXCITATION:	PERMANANT MAGNET (PMG)
GENERATOR EMISSIONS TYPE:	STATIONARY EMERGENCY (TIER 3)
GENERATOR FUEL TYPE:	DIESEL
GENERATOR ENCLOSURE TYPE:	SKIN TIGHT
SOUND ATTENUATION:	LEVEL 2
GENERATOR MOUNTED BREAKER:	800A/3P
GENERATOR LOAD BANK:	REMOTE MOUNTED

1.02 DESCRIPTION OF SYSTEM

- A. After failure of normal power, the engine starts automatically, attains rated voltage and frequency and in conjunction with the automatic transfer switch, transfers power to the load in less than 10 seconds from the time of the power failure signal. Upon restoration of utility power, automatically retransfer load back to normal power, and then shuts down the generator (after programmable cool down period) and returns to readiness for another operating cycle.
- B. Generator shall meet most current and adopted emissions standards in project location for an Emergency Standby application.

1.03 QUALITY ASSURANCE

- A. Built to NEMA Standards, U.L. 2200 listed (generator set), and in accordance with NFPA 70. The engine generator set will be a packaged unit and will be the

product of a single manufacturer, with all warranties for the complete unit provided by the factory.

1.04 REQUIREMENTS OF REGULATORY AGENCIES

- A. The electric generating system consists of a prime mover, generator, governor, coupling and all controls.
- B. Conform to N.E.C. and applicable inspection authorities.

1.05 WARRANTY

- A. The manufacturer and dealer shall provide a warranty which shall be for a period of five (5) years (1500 operating hours) from date of initial startup of the system.
 - 1. The warranty shall include repair parts, labor, reasonable travel expense necessary for repairs at the jobsite, and expendables (lubricating oil, filters, antifreeze, and other service items made unusable by the defect) used during the course of repair.
 - 2. Applicable deductible costs shall be specified in the manufacturer's warranty.
 - 3. Submittals received without written warranties as specified will be rejected in their entirety.

1.06 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures.
- B. Clearly indicate all connection points, installed weight, dimensions, clearance requirements, accessory description, fuel requirements, air quantity requirements, electrical rating, power factor, short circuit available amperes (R.M.S. value), voltage regulator type, temperature rise of the alternator, ambient air rating of the radiator, recommended pipe sizes and routing.
- C. **Indicate the site rated value for kW and kVA.**

1.07 DELIVERY, STORAGE AND HANDLING

- A. Generator Supplier shall deliver generator set (FOB) to the site, unload, and set directly onto the concrete pad.

1.08 OPERATION AND MAINTENANCE DATA

- A. Include complete data in accordance with 01 78 23 - Operation and Maintenance Data for maintaining and operating the unit including fuel requirements, lubrication requirements, exercising, tests to be performed, spare parts list,

troubleshooting guide, description of operation. Include a minimum of four (4) hours for Owner instruction.

1.09 MOTOR STARTING CAPABILITY

A. Motor Starting Capability

1. The engine generator set shall have sufficient starting kVA to withstand the loading sequence listed below. The staggered start sequencing indicated will be provided from combination of the ATS and plant PLC SCADA system programming, separate from generator system. During motor starting, instantaneous voltage dip shall not exceed the limits indicated per individual step. The Contractor shall submit calculations with the shop drawing submittal that confirm the unit's conformance with this requirement.

1.10 SUPPLIER EXPERIENCE AND CAPABILITIES

- A. It is the intent of this Specification that all equipment specified in this Section shall be furnished by a single source supplier who shall assume system responsibility along with the Contractor.
- B. The engine generator set supplier shall be normally engaged in the assembly, installation, repair, and maintenance of generation equipment. The supplier shall have provided at least five (5) systems of equal or greater complexity/size in the last year.
- C. The supplier shall be a factory authorized sales, parts, and service representative of the engine manufacturing company. The supplier shall demonstrate that it has spare parts in stock to service and maintain the engine and to repair the unit in 48 hours or less for most failures.
- D. The supplier shall have a service depot within a 150 mile radius of the project site.
- E. The supplier shall modify or supplement the supplier's "standard products" to meet these specifications. Standard products of a particular supplier that do not meet the functional and technical requirements of the specification are not acceptable.
- F. The supplier shall have qualified, trained service personnel on staff who are capable of maintaining and repairing the equipment. The supplier shall be capable of offering an extended service contract after completion of the warranty period, including 24 hour, 7 day per week emergency services.
- G. Upon request, the supplier shall submit:

1. List of five (5) projects referenced above, including customer's name, contact person, and phone number.
2. Description of service contract capability, including number of personnel, their location, and types of service contract available.

1.11 SITE REQUIREMENTS

A. Noise

1. The power generation system for this application shall meet the following noise requirements.
 - a. Noise from the generation equipment shall not exceed 75dB over background noise 25 feet from the enclosure in any direction with the unit operating at full standby load conditions.
 - b. Noise from the generation equipment shall meet all City and State requirements. General requirements are:

MAXIMUM ALLOWABLE NOISE LEVELS

Octave Band Frequency	Maximum Decibel Level
20-75	65
75-150	60
150-300	55
300-600	46
600-1200	40
1200-2400	34
2400-4800	31
4800 & over	28

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. The generator set shall be as manufactured by:
 1. Caterpillar
 2. Cummins and Power Systems
 3. Generac Power Systems
 4. Prior approved equal
- B. The engine, generator and all major items must be manufactured in the United States.

2.02 RATINGS

- A. 277/480 VAC output voltage at 60Hz, 3 phase.
- B. 400 Standby eKW @ .8PF, 500 kVA

1. The standby (maximum or intermittent) rating of the unit shall not exceed the fuel rate limit of the engine based on two (2) hours of standby operation out of any 24 hour period at rated speed and rated voltage. The ambient temperature is 120 degrees F. This is measured two (2) feet from the end bearing housing of the generator in line with the shaft. The standby rating shall be no greater than 10% above the prime rating. The rating must be adjusted for the elevation of the installation if necessary. The engine fuel rate must not be adjusted higher than the fuel rate recommended by the engine manufacturer.
2. The submittal shall include the efficiency of a similar production generator and the fuel utilization of a similar production engine after 4 hours of continuous operation at prime rated load. This data shall be based on #2 diesel fuel with a cetane rating of 40.
3. These ratings must be substantiated by the manufacturer's certified standard published curves. Special ratings or maximum ratings are not acceptable.

C. Ambient temperature: -35 Degrees F. minimum to +120 Degrees F. maximum

2.03 ENGINE

A. Type

1. Diesel utilizing number 2 fuel
2. Liquid cooled
3. Four cycle
4. 1800 RPM
5. Full pressure lubrication system; engine driven lube oil pump
6. Lube oil filters
7. Spring loaded bypass valve
8. Lube oil cooler
9. Lube oil
10. Fuel transfer pump
11. Fuel priming pump
12. Fuel oil cooler
13. Flexible fuel lines (labeled for fuel flow direction)
14. Engine mounted fuel oil filter
15. Engine driven water pump
16. Dry type air cleaners with service indicators
17. Closed Loop Crank Case breather system (No oil may be routed to dump on the floor, all must be recycled)

2.04 GOVERNOR

- A. Isochronous governor (electronic type with magnetic pickup) +/- 1/4% speed regulation no load to full load

2.05 GENERATOR (IN ACCORDANCE WITH NEMA STANDARD MG1-22.40)

A. Type

1. 277/480 volt, 3 phase, wye connected
2. Drip proof
3. Permanent magnet excitation
4. Brushless exciter with static regulator containing no moving parts
5. Field circuit with inherent protection against excessive field currents or voltages
6. Heavy duty single ball bearing type
7. Direct coupled to the engine through a semiflexible coupling
8. NEMA Class "H" insulation
9. NEMA Class "F" temperature rise (115o C maximum)
10. Rating and voltage stamped on a permanent nameplate
11. Voltage regulator (solid state), +/- 2% from no load to full load
12. Voltage level adjustment, +/- 5%

2.06 OUTPUT CIRCUIT BREAKER

- A. The generator output circuit breaker(s) shall be mounted on the generator. The circuit breaker shall be molded case, provided with an adjustable electronic trip unit with adjustable LSIG functionality. In addition, the trip unit shall have a ground fault alarm function which is separately adjustable from the ground fault trip setting. The breaker shall have shunt-trip.
- B. Customer Power: Circuit breaker to be molded case, thermal magnetic, 800amperes, 3 pole, 480 VAC, 65 KAIC minimum. Circuit breaker shall incorporate an electronic trip unit with adjustable LSIG trip function.
- C. Load Bank: Circuit breaker to be molded case, thermal magnetic, 400 amperes, 3 pole, 480 VAC, 65 KAIC minimum. Circuit breaker shall incorporate an electronic trip unit with adjustable LSI trip function.

2.07 INSTRUMENTATION AND CONTROLS

- A. The generator control panel shall be generator mounted and shall provide all operating, monitoring and control functions for the generator set.
- B. The control panel shall include the following functional requirements:
1. LCD display with text based alarm/event descriptions.
 2. Automatic and manual start/stop controls
 3. Local run/off/auto control
 4. Emergency stop pushbutton
 5. Lamp test
 6. Voltage control

7. Speed control
 8. Password protected system programming
 9. Spare relay - programmable
- C. Controls shall provide the following keypad accessible digital readouts for the engine and generator:
1. Engine
 - a. Engine oil pressure
 - b. Engine oil temperature
 - c. Engine coolant temperature
 - d. Engine RPM
 - e. Battery Volts
 - f. Hours Run
 2. Generator
 - a. AC Voltage (L-L & L-N)
 - b. AC Amps
 - c. Generator AC Frequency
 - d. KW (total & per phase)
 - e. KVA (total & per phase)
 - f. KVAR (total & per phase)
 - g. Power Factor (Average and per phase)
 - h. KWhr (total)
 - i. KVARhr (total)
 - j. % of rated KW (total)
 3. Voltage Regulation
 - a. DC voltage
 - b. DC current
- D. Alarms and Shutdowns (Engine)
1. Low oil pressure alarm/shutdown
 2. High coolant temperature alarm/shutdown
 3. Loss of coolant shutdown
 4. Overspeed shutdown
 5. Overcrank shutdown
 6. Low coolant level alarm
 7. Low fuel level alarm
 8. Emergency stop shutdown
 9. Low coolant temperature alarm
 10. Low battery voltage alarm
 11. High battery voltage alarm
 12. Control switch not in auto position alarm
 13. Battery charger failure alarm
- E. Alarms and Shutdowns (Generator)
1. Generator over voltage

2. Generator under voltage
3. Generator over frequency
4. Generator under frequency
5. Generator reverse power
6. Generator overcurrent
7. Generator breaker open

F. Alarms and Shutdowns (Voltage Regulation)

1. Loss of excitation alarm/shutdown
2. Instantaneous over excitation alarm/shutdown
3. Time over excitation alarm/shutdown
4. Rotating diode failure
5. Loss of sensing
6. Loss of PMG

G. Auxiliary

1. Provide (6) programmable discrete inputs.
2. Provide (15) discrete outputs which shall be of the dry contact type rated for 120VAC. These outputs shall be configurable in the field but shall be initially configured to provide the following:
 - a. Generator Running
 - b. Generator not in auto
 - c. Generator Pre-High Engine Temp
 - d. Generator High Engine Temp
 - e. Generator Overspeed
 - f. Generator Low Engine Temp
 - g. Generator Low Coolant Level
 - h. Generator Pre-Low Oil Pressure
 - i. Generator Low Oil Pressure
 - j. Generator Fuel Tank Leak
 - k. Generator Battery Charger Fault
 - l. Four (4) Spares
3. Provide (1) programmable analog output (4-20mA):
 - a. One analog (4-20mA) output to indicate continuous fuel level to SCADA Panel.
4. Provide (1) Modbus TCP/IP protocol communication network connection to SCADA. A protocol conversion gateway shall not be required.

H. Enclosure

1. Mounted Integral to Generator

I. Indicating Lights

1. Low oil pressure
2. High coolant temperature

3. Overspeed
4. Overcrank
5. Emergency stop
6. Fault shutdown
7. Fault alarms
8. 3 Spare lights/4 spare inputs
9. Customer programmable (shutdown or alarm) to spare alarm or fault LEDs

J. Pre-alarm and LED indicators for

1. Approach high coolant temperature
2. Low coolant temperature (70 degrees F.)
3. Approach low oil pressure
4. Low DC volts
5. System not in "automatic"
6. Low fuel level
7. Fuel in rupture basin

2.08 REMOTE COMMUNICATIONS

- A. Generator control shall include an external Ethernet communication port for connecting to the plant SCADA via Modbus TCP/IP protocol.
- B. Remote serial annunciator panel (RSA) shall be furnished loose for installation at the site by the Electrical Contractor. The RSA shall enable the operator to monitor the status of the generator set from a remote location. The RSA shall be connected via RS-485 Serial Communication using Modbus or other industry standard protocol and a Belden data cable.

2.09 STARTING SYSTEM

- A. 24 volt DC starter motor(s)
- B. Automatic reset circuit breaker to protect against butt engagement of starter motor(s)
- C. Batteries, low maintenance, lead acid type (low antimony) adequately sized per the ambient temperatures stated
- D. Corrosion resistant or coated steel battery rack
- E. Required battery cables

2.10 BATTERY CHARGER

- A. Automatic mode switching type. 6 ampere minimum rating.

- B. Rating of at least 1/20 of the ampere hour rating of the batteries
- C. Factory preset ranges – not field adjustable
- D. DC output +/- 0.2% with AC input variation of +/- 10%
- E. DC voltmeter
- F. DC ammeter
- G. NFPA malfunction alarm contacts

2.11 JACKET WATER HEATER(S)

- A. 240 volts, single phase, sized to manufacturer's recommendations
- B. Adjustable thermostatic control
- C. Isolation valves
- D. Sized to maintain engine jacket water temperature at a minimum of 120 degrees F. when the engine is idle.

2.12 COOLING SYSTEM, ENGINE MOUNTED (AMBIENT RATING OF -35 F TO +120F)

- A. Vertical core with built in expansion tank
- B. Flanged for direct duct connection
- C. Engine driven blower fan
- D. OSHA type fan and belt guards
- E. Low coolant level contactor
- F. 50% ethylene glycol inhibited antifreeze liquid with additives

2.13 EXHAUST SYSTEM

- A. Critical type silencer with thimble.
- B. Silencer configuration shall be for horizontal installation with a bottom inlet, to be mounted to the roof of the generator room.
- C. Mechanical contractor to construct roof support and connect silencer to generator as required. The electrical contractor shall provide dimensions required for mechanical to install.

2.14 FUEL TANK SYSTEM

- A. 24 hour fuel supply at 100% load (650 gallon minimum)

- B. Mounted under the generator, double walled with leak detention to meet PCA requirements.
- C. Coordinate foot print during submittal phase. The intent is to allow the generator manufacturer the freedom to provide a tank that best meets the site requirements. Note: any tank size must fit inside the space available and allow for the generator to also fit in the space, pay special attention to the installation method for the site to ensure the generator will be able to be placed in the space without issues.
- D. Inlet - exterior mounted fuel fill box
- E. Vents top of tank, Normal, Emergency, & Rupture Basin shall be extended through the building wall & include non-corrosive aluminum vent extensions & vent caps. Extensions shall be provided by generator manufacturer and installed by mechanical contractor on site.
- F. Engine return line top of tank
- G. Low level fuel alarm with contacts for remote annunciation, prewired to generator control panel.
- H. Visual Level Indicator
- I. Leak detection alarm.
- J. Fuel level gauge (4-20mA analog output).
 - 1. The generator fuel gauge shall be calibrated to its zero value in the plant SCADA system prior to filling with diesel to provide an accurate high and low level signal.
- K. Drain petcock at bottom of tank.
- L. Utilize flexible metal hose for final connections of fuel supply and return lines
- M. A (4) point lifting means for the total weight of the system less fuel shall be designed into the base.

2.15 ACCESSORIES

- A. Glycol coolant mixture (50%)
- B. Initial fuel fill (blended). See Part 3 for additional information.
- C. OSHA approved ear protectors (four sets).
- D. Provide linear-spring-type vibration isolators between the engine frame and enclosure and/or concrete pad as applicable.

2.16 LUBE OIL SYSTEM

- A. Forced-feed lubrication system with piston cooling, lube oil circulating pump with safety valve, lube oil filter, lube oil heat exchanger, filler neck, dip stick, and closed crankcase breather system.

2.17 REMOTE MOUNTED LOAD BANK

- A. Provide a remote mounted load bank automatically activates in conditions of low load to maintain proper load on the generator to prevent wet stacking.
- B. The load bank shall be rated at 200 kW, 480V, 3PH
- C. The load bank shall be provided with the following features as minimum:
 - 1. Shall utilize engine air for cooling
 - a. The generator controls shall incorporate a "load bank cooldown" feature which allows the engine to run a user definable duration upon engine shut down initiation to allow the load bank to adequately cool itself prior to the engine shutting down.
 - 2. Shall be provided with an integral control panel incorporating the following features
 - a. A power On-Off switch
 - b. A master load On-Off switch
 - c. Automatic Load Step Controller
 - d. Individual Load Step Toggle Switches
 - e. Provide a 120V control power transformer.
 - f. Shall incorporate a built-in thermal switch which shall drop all load if an overtemperature condition is detected.
 - 3. Shall contain a corrosion resistant aluminized steel frame provided with lifting eyes and a radiator duct flange to simplify installation.
 - 4. The heater elements shall be of the tubular Calrod Type in lieu of wound alloy wire.
- D. Manufactures:
 - 1. Avtron
 - 2. Approved Equal

2.18 ALL STEEL SKIN TIGHT STYLE WEATHER PROOF ENCLOSURE

- A. A weatherproof enclosure, designed to allow for full load operation of the engine generator system and all of its accessories, sized for the exact unit being installed, shall be supplied. The enclosure shall be sized and equipped with adequate doors for ease of inspection and servicing.
- B. The enclosure shall be insulated with a high density foam insulation

- C. The air openings shall include motor-operated intake and gravity exhaust dampers with fixed louvers on the intake and a 90 degree hood on the outlet sized to allow proper air flow (restriction not to exceed .5" H2O)
- D. Doors shall be installed to allow sufficient access to the generator set and all accessories. All doors shall be hinged and equipped with positive locking assemblies and handles and be weather stripped.
- E. The exhaust silencer shall be internally mounted and equipped with a vertical exhaust and a rain cap.
- F. The enclosure shall arrive at the jobsite completely wired (battery charger, jacket water heater, louver motors, etc.) and ready for final installation.
- G. Load Center
 - 1. Enclosure shall be supplied with a 120/240V, 1PH load center as required to feed all generator auxiliary power requirements such as battery charger and jacket heater.
 - 2. A power distribution block is an acceptable alternative. A single point of power connection is to be provided for all auxiliary load electrical connections.
- H. Provide enclosure with enclosure mounted LED lights to sufficiently light the interior of the enclosure to 20 foot candles. Provide 2 enclosure mounted WP, GFCI duplex general purpose receptacles.
- I. Provide LED wall packs on the exterior of the enclosure to provide 10 foot candles minimum immediately around the generator for maintenance. At a minimum, 1 light fixture shall be installed on each of the two sides of the generator where service doors exist. Exterior lights shall be on their own light switch and be provided with integral photocell. Light fixture shall be manufactured by RAB or Approved Equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Coordinate with Electrical Contractor the unloading and proper placement of the engine generator set inside the generator space.
- B. Provide all power feeders per Drawings and connect.
- C. Tighten all lugs and bolts to manufacturer's recommendations.
- D. Neatly dress conductors and bundle with nylon cable ties.

- E. Provide all required control connections between generator control panel and ATS, between generator control panel and SCADA, and between SCADA and ATS.
- F. Provide grounding at generator set location with ground rods and copper conductors as specified in Section 26 05 26 - Grounding and Bonding for Electrical Systems and as indicated on the Drawings.
- G. Use touch-up paint, as recommended by the manufacturer, to repair scratches and other surface defects.

3.02 CHECKOUT & STARTUP

- A. Electrical Contractor shall contract with manufacturer of the electric generating plant and associated items covered herein to provide factory trained technicians to check out the completed installation and to perform an initial startup inspection to include:
 - 1. Ensuring the engine starts (both hot and cold) within the specified time.
 - 2. Verification of engine parameters are within manufacturer's recommendations.
 - 3. Set no load frequency and voltage.
 - 4. Single step load pickup per NFPA 110-1985, Paragraph 5-13.2.
 - 5. Transient and voltage dip responses and steady state voltage and speed (frequency) checks.
 - 6. Test all automatic shutdowns of the engine generator.
- B. Furnish to engineer, a report indicating that installation has been tested by a manufacturer's representative and is installed and operating properly.

3.03 TRAINING

- A. Training for the Owner's personnel shall be for not less than eight (8) hours on the power generation system. The eight hours shall consist of up to two (2) separate four (4) hour sessions on Site.
- B. All training sessions shall be at times that are preapproved with the Owner (7 days minimum advance notice).
- C. Training shall be in accordance with Division 1 requirements.

3.04 WIRING

- A. Wiring of the engine generator set, switchgear, lighting, outlets, panelboard, transformer, ventilation and other components of the integrated generation system shall meet all State requirements. These requirements shall include, but are not limited to:

1. Applying and paying for an electrical construction permit.
2. Installation by an electrician appropriately licensed by the State in which the project is located in.
3. Inspection and approval by an electrical inspector recognized by the State to which the project is located in.

3.05 TESTING

A. Testing During Fabrication

1. Engine Generator. The power generation system manufacturer or fabricator shall have:
 - a. The power generation system is to be tested as a complete unit including engine, generator, excitation system, together with all subsystems in the enclosure and cooled by the engine radiator and fan.
 - b. The manufacturer shall provide all equipment for the test including, but not limited to, ammeters, voltmeters, fuel supply, frequency meter, and load banks capable of 10% maximum steps to 100% of the engine generator's continuous standby rating; and the addition, in one step of 50% of the continuous standby rating from a 50% continuous standby rating load point, or removal of the total load from the generator in one step. The load banks shall be connected through the switchgear. The load bank shall be connected to the power generation system's load terminals. The test program will cover the following items:
 - 1) Extended operation at 100% of continuous-standby rating, 2 (two) hours minimum.
 - 2) 50% load to 100% load test with a +10%-15% from nominal voltage dip, maximum, permitted with frequency fluctuation measurement. Code F motor inrush characteristics. Frequency deviation shall not exceed 3 cycles for 2 seconds.
 - 3) Engine protective device evaluation.
 - 4) No load operation with an addition of load to 50% of rating with 15% voltage dip maximum and frequency fluctuation not exceeding 2 cycles for 2 seconds.
 - 5) Various 10% load additions and subtractions.
 - 6) Evaluation of subsystems, noise, component installation and interconnections, workmanship, quality, engine and generator performance, etc.
 - 7) The test program will not start without all required equipment, including but not limited to load banks and voltmeter as required.

B. Site Testing

1. After installation, but prior to acceptance for substantial completion, the system shall undergo formal onsite testing. This testing will be witnessed by representatives of the Owner and the Engineer. The testing will include, but not be limited to:
 - a. Demonstration of system features and functions.
 - b. Machine performance.
 - c. Use project loads and a separate resistive load bank equal to the generator capacity for testing purposes. Unit shall be tested as follows:
 - 1) With generator in a "cold start" condition and load at normal operating level, initiate a normal power failure by opening all switches or breakers supplying normal power to the facility. Test load shall be that load which is served by the generator.
 - 2) Observe and record the time delay on start.
 - 3) Observe and record the cranking time until the generator starts and runs.
 - 4) Observe and record the time required to come up to operating speed.
 - 5) Record voltage and frequency overshoot.
 - 6) Observe and record time required to achieve steady-state condition with all switches transferred to the emergency/standby position.
 - 7) Record voltage, frequency and amperes.
 - 8) Continue load test with building load for one (1) hour, observing and recording load changes and the resultant effect on voltage and frequency.
 - 9) Return normal power to the facility, record the time delay on retransfer to normal (set to 15 minutes minimum) and the time delay on the generator cool down period and shutdown.
 - 10) Confirm and record the time delays associated with the delayed transition feature of the switch and the "pre-transfer" signal to SCADA.
 - 11) Perform a crank cycle test. Utilize any method recommended by the manufacturer to prevent the generator from running. Put the control switch into the "run" position to cause the generator

to crank. Observe the complete crank/rest cycle specified and record.

- 12) After successful testing with the available facility loads, provide a resistive load bank to test the generator at full specified load at 1.0 power factor. Run generator at full load for two (2) hours. Record generator oil pressure, water temperature, and battery charge rate, voltage, frequency, and amperes at 5 minute intervals for the first 15 minutes and at fifteen minute intervals thereafter.
- 13) Test all safeties specified, as recommended by the manufacturer.
 - d. Perform testing at time preapproved by Owner and Engineer (7 day prior notice, minimum).
 - e. Submit record of site test procedures and results and include a copy in the O&M manuals.
2. If the system is not accepted or does not perform satisfactorily, repairs shall be completed, and the unit retested until it performs to the Owner, Utility, and the Engineer's satisfaction.

3.06 FUEL

- A. Provide all diesel fuel for initial startup, training and testing procedures.
- B. Provide \$3500 worth of fuel in the fuel tank (winter blend diesel fuel) at project completion. Intent is to leave the tank filled to at least half full capacity prior to leaving site. Provide copies of all fuel receipts to the Engineer to confirm quantity of fuel provided. Demonstrate fuel tank level to the Engineer and Owner prior to leaving site at project completion.

3.07 SUPPLIES AND SPARE PARTS

- A. Provide all supplies, spare parts, expendable items and related equipment for initial startup, training and testing procedures.
- B. At project completion, provide Owner with a complete set of spare parts for the equipment, including, but not limited to lamps, fuses, etc. Provide twenty (20) percent spare fuses and lamps of each type furnished under this Section, but not less than six (6) of each type.

END OF SECTION 26 32 13

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SECTION 26 36 00
AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.01 SUMMARY

- A. Low voltage automatic transfer switch.
 - 1. Automatic Transfer Switch

1.02 DESCRIPTION OF SYSTEM

- A. An electrically operated switch shall automatically operated during a utility power service interruption and the system shall also be manually controlled to transfer the load from the utility source to the fixed engine generator source.

1.03 CODES AND STANDARDS

- A. UL 1008 - Standard for Transfer Switch Equipment
- B. NFPA 70 - National Electrical Code
- C. NFPA 99 - Essential Electrical Systems for Health Care Facilities
- D. NFPA 110 - Emergency and Standby Power Systems
- E. IEEE Standard 446 - IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
- F. NEMA Standard ICS10-1993 (formerly ICS2-447) - AC Automatic Transfer Switches

1.04 ACCEPTABLE MANUFACTURERS

- A. ASCO Power Technologies - Series 7000
- B. Prior Approved Equal

1.05 SUBMITTALS

- A. Furnish a report indicating that the transfer switch is adjusted to the manufacturer's recommendations.
- B. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation and servicing in accordance with ISO 9001.
- C. As programmed ATS set points and O&M manual.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Store in a dry area, protected from the weather.
- B. The manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this specification including compliance with the above codes and standards and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the specifications, other than those stipulated at the time of the submittal, shall be included in the certification.

PART 2 - PRODUCTS

2.01 EQUIPMENT

Ampacity:	800 A
Service Entrance Rated:	Yes
Main Circuit Breaker Required	Yes - Fixed Mounted
Maintenance Bypass Required:	No
Voltage:	277/480V 3PH
kAIC Rating:	65 KAIC
# of Poles:	3 Pole Non-Switched
Transition Type:	Neutral
Enclosure Type:	Delayed
Lug Type:	NEMA 1
Arc Flash Maintenance Switch:	Compression
	Yes

2.02 AUTOMATIC TRANSFER SWITCH

- A. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single solenoid mechanism. Main operators utilizing overcurrent disconnect devices, linear motors or gears are not permitted. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency.
- B. Transfer switch sizes shall use one type of main operator for ease of maintenance and commonality of parts.
- C. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life.
- D. Main contacts shall be silver composition. Switches rated 600 amperes and above shall have segmented, blow on construction for high withstand and close on capability and be protected by separate arcing contacts.

- E. Inspection of contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power conductors. Switches rated 600 amps and higher shall have front removable and replaceable contacts. Stationary and moveable contacts shall be replaceable without removing power conductors and/or bus bars.
- F. Designs utilizing components of molded case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources are not permitted.
- G. Where neutral conductors are solidly connected, a neutral conductor plate with fully rated AL-CU pressure connectors shall be provided.

2.03 MICROPROCESSOR CONTROLLER

- A. The controller's sensing and logic shall be provided by a single built in microprocessor for maximum reliability, minimum maintenance, and the ability to communicate serially through an optional serial communication module or Ethernet connectivity module.
- B. A single controller shall provide twelve selectable nominal voltages for maximum application flexibility and minimal spare part requirements. Voltage sensing shall be true RMS type and shall be accurate to $\pm 1\%$ of nominal voltage. Frequency sensing shall be accurate to $\pm 0.2\%$. The panel shall be capable of operating over a temperature range of -20 to +60 degrees C and storage from -55 to +85 degrees C.
- C. The controller shall be connected to the transfer switch by an interconnecting wiring harness. The harness shall include a keyed disconnect plug to enable the controller to be disconnected from the transfer switch for routine maintenance. Sensing and control logic shall be provided on multilayer printed circuit boards. Interfacing relays shall be industrial grade plug in type with dust covers. The panel shall be enclosed with a protective cover and be mounted separately from the transfer switch unit for safety and ease of maintenance. The protective cover shall include a built in pocket for storage of the operator's manuals.
- D. Owner connections shall be wired to a common terminal block to simplify field wiring connections.
- E. The controller shall meet or exceed the requirements for Electromagnetic Compatibility (EMC) as follows:

EN 55011	Emission standard - Group 1, Class A
EN 50082-2:1995	Generic immunity standard
EN 61000-4-2:1995	Electrostatic discharge (ESD) immunity
ENV 50140:1993	Radiated Electro-Magnetic field immunity
EN 61000-4-4:1995	Electrical fast transient (EFT) immunity

EN 61000-4-5:1995	Surge transient immunity
EN 61000-4-6:1996	Conducted Radio-Frequency field immunity
IEEE472	Ring Wave Test

2.04 ENCLOSURE

- A. Standard door mounted switches and indicating lights described shall be integrated into a flush mounted, interface membrane or equivalent in the interior enclosure door for easy viewing & replacement. The panel shall include a manual locking feature to allow the user to lockout membrane-mounted control switches to prevent unauthorized tampering.

2.05 ACCESSORIES

- A. Pre-Transfer Signal: The transfer switch shall be provided with an adjustable “pre-transfer” signal (dry contact) that can be wired to the SCADA system for monitoring. The signal shall be active in transfer in either direction (from utility to generator or from generator back to utility). The intent of the signal is to wire it to SCADA so that the large motor loads can be sequenced off prior to transfer and then sequenced on after transfer.
- B. Auxiliary Contacts: Provide two (2) auxiliary contacts that indicate “Normal” position of the switch and two (2) auxiliary contacts that indicate “Emergency” position of the switch. The contacts shall be available for the Owner’s use.
- C. Delayed Transition Operation: The automatic transfer switch shall be of the “delayed transition” type, including an “intermediate Off” position during transfer along with an adjustable time delay to allow large motors to coast to a complete stop and transformer fields to completely decay prior to transfer. This feature ensures that inductive loads are “re-energized” after transfer with only normal starting inrush currents.

2.06 CONTROLLER DISPLAY AND KEYPAD

- A. A four line, 20 character LCD display and keypad shall be an integral part of the controller for viewing available data and setting desired operational parameters. Operational parameters shall also be available for viewing and limited control through the communications interface port. The following parameters shall only be adjustable via DIP switches on the controller:
 - 1. Nominal line voltage and frequency
 - 2. Single or three phase sensing
 - 3. Operating parameter protection
 - 4. Transfer operating mode configuration
 - 5. (Open transition)
- B. Instructions and controller settings shall be easily accessible, readable and accomplished without the use of codes, calculations, or instruction manuals.

2.07 VOLTAGE, FREQUENCY AND PHASE ROTATION SENSING

- A. Voltage and frequency on both the normal and emergency sources shall be continuously monitored, with the following pickup, dropout, and trip setting capabilities (values shown as % of nominal unless otherwise specified):

<u>Parameter</u>	<u>Source(s)</u>	<u>Dropout / Trip</u>	<u>Pickup / Reset</u>
Undervoltage	N&E, 3 Phase	70% to 98%	85% to 100%
Overvoltage	N&E, 3 Phase	102% to 115%	2% below trip
Underfrequency	N&E	85% to 98%	90% to 100%
Overfrequency	N&E	102% to 110%	2% below trip
Voltage Unbalance	N&E	5% to 20%	1% below trip

- B. Repetitive accuracy of settings shall be within $\pm 0.5\%$ over an operating temperature range of -20°C to 60°C (-4°F to 140°F).
- C. Voltage and frequency settings shall be field adjustable in 1% increments either locally with the display and keypad or remotely via the communications interface port.
- D. The controller shall be capable (when activated by the keypad or the communications interface port) of sensing the phase rotation of both the normal and emergency sources. The source shall be considered unacceptable if the phase rotation is not the preferred rotation selected (ABC or CBA).
- E. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage on all 3 phases, frequency, and phase rotation.

2.08 TIME DELAYS

- A. An adjustable time delay of 0 to 6 seconds shall be provided to override momentary normal source outages and delay transfer and engine starting signals. Capability shall be provided to extend this time delay to 60 minutes by providing an external 24 VDC power supply.
- B. A time delay shall be provided on transfer to emergency, adjustable from 0 to 60 minutes, for controlled timing of transfer of loads to emergency.
- C. Two time delay modes (which are independently adjustable) shall be provided on re-transfer to normal. One time delay shall be for actual normal power failures and the other for the test mode function. The time delays shall be adjustable from 0 to 60 minutes. Time delay shall be automatically bypassed if the emergency source fails, and the normal source is acceptable.
- D. A time delay shall be provided on shut down of engine generator for cool down, adjustable from 0 to 60 minutes.

- E. A time delay activated output signal shall also be provided to drive an external relay(s) for selective load disconnect control. The controller shall have the ability to activate an adjustable 0 to 5 minute time delay in any of the following modes:
 - 1. Prior to transfer only.
 - 2. Prior to and after transfer.
 - 3. Normal to emergency only.
 - 4. Emergency to normal only.
 - 5. Normal to emergency and emergency to normal.
 - 6. Transfer conditions or only when both sources are available.
- F. Time delays shall be adjustable in 1 second increments, except the extended parallel time, which shall be adjustable in 0.01 second increments.
- G. Time delays shall be adjustable by using the LCD display and keypad or with a remote device connected to the communications interface port.

2.09 ADDITIONAL FEATURES

- A. Membrane type switches shall be provided for the test and retransfer to normal functions. The test position will simulate a normal source failure. The retransfer to normal position shall bypass the time delays on retransfer to normal.
- B. A SPDT contact, rated 5 amps at 30 VDC, shall be provided for a low voltage engine start signal. The start signal shall prevent dry cranking of the engine by requiring the generator set to reach proper output and run for the duration of the cool down setting, regardless of whether the normal source restores before the load is transferred.
- C. Auxiliary contacts rated 10 amps, 250 VAC shall be provided consisting of two contacts, closed when the ATS is connected to the normal source and two contacts closed, when the ATS is connected to the emergency source.
- D. LED indicating lights shall be provided; one to indicate when the ATS is connected to the normal source (green) and one to indicate when the ATS is connected to the emergency source (red).
- E. LED indicating lights shall be provided and energized by controller outputs. The lights shall provide true source availability of the normal and emergency sources, as determined by the voltage sensing trip and reset settings for each source.
- F. A membrane switch shall be provided on the membrane panel to test all indicating lights when pressed.
- G. Provide the ability to select "commit/no commit to transfer" to determine whether the load should be transferred to the emergency generator if the normal source restores before the generator is ready to accept the load.

- H. Terminals shall be provided for a remote contact which opens to signal the ATS to transfer to emergency and for remote contacts which open to inhibit transfer to emergency and/or retransfer to normal. Both of these inhibit signals can be activated through the keypad or the communications interface port.
- I. The controller shall be capable of accepting a normally open contact that will allow the transfer switch to function in a non-automatic mode when a non-automatic version of the user interface membrane is furnished.
- J. Engine Exerciser - The controller shall provide an internal engine exerciser. The engine exerciser shall allow the user to program up to seven different exercise routines. For each routine, the user shall be able to:
 - 1. Enable or disable the routine.
 - 2. Enable or disable transfer of the load during routine.
 - 3. Set the following:
 - a. start time
 - b. time of day
 - c. day of week
 - d. week of month (1st, 2nd, 3rd, 4th, alternate or every)
 - 4. Set the duration of the run.
 - a. At the end of the specified duration the switch shall transfer the load back to normal and run the generator for the specified cool down period. A 10 year life battery that supplies power to the real time clock in the event of a power loss shall maintain time and date information.
- K. Key Locking Feature - The control switches on the interface membrane shall be capable of being locked via password protected screens on the controller LCD display to prevent unauthorized tampering. A red LED indicator shall be illuminated on the interface membrane when the membrane controls are locked.
- L. System Status - The controller LCD display shall include a "System Status" screen which shall be readily accessible from any point in the menu by depressing the "ESC" key a maximum of two times. This screen shall display a clear description of the active operating sequence and switch position. For example:
 - 1. Normal Failed
 - 2. Load on Normal
 - 3. TD Normal to Emerg
 - 4. 2min15s
- M. Controllers that require multiple screens to determine system status or display "coded" system status messages, which must be explained by references in the operator's manual, are not permitted.

- N. Self-Diagnostics - The controller shall contain a diagnostic screen for the purpose of detecting system errors. This screen shall provide information on the status input signals to the controller which may be preventing load transfer commands from being completed.
- O. Communications Interface Module - The controller shall be able to connect via an Ethernet connectivity module (over standard 10baseT Ethernet networks). This module shall allow for seamless integration of existing or new communication transfer devices. Standard software specific for transfer switch applications shall be available by the transfer switch manufacturer. This software shall allow for the monitoring, control and setup of parameters. The transfer switch shall also be able to interface to 3rd party applications using ModbusTCP/IP open standard protocols. The communication interface modules shall be as follows:
1. ASCO Accessory 72A (RS-485 Serial)
 2. ASCO Accessory 72E (10BaseT Ethernet)
 3. ASCO Accessory 92A (PSTN dial-up modem)
- P. Data Logging - The controller shall have the ability to log data and to maintain the last 99 events, even in the event of total power loss. The following events shall be time and date stamped and maintained in a non-volatile memory:
- Q. Event Logging
1. Data and time and reason for transfer normal to emergency.
 2. Data and time and reason for transfer emergency to normal.
 3. Data and time and reason for engine start.
 4. Data and time engine stopped.
 5. Data and time emergency source available.
 6. Data and time emergency source not available.
- R. Statistical Data
1. Total number of transfers.
 2. Total number of transfers due to source failure.
 3. Total number of days controller is energized.
 4. Total number of hours both normal and emergency sources are available.
- S. External DC Power Supply - An optional provision shall be available to connect an external 24 VDC power supply to allow the LCD and the door mounted control indicators to remain functional when both power sources are dead.
1. ASCO accessory 1G.
- T. Ground fault protection shall be provided for all circuit breakers rated 1000 amperes or more or as indicated on the Drawings.

2.10 WITHSTAND AND CLOSING RATINGS

- A. The ATS shall be rated to close on and withstand the available RMS symmetrical short circuit current at the ATS terminals with the type of overcurrent protection shown.
- B. The ATS shall be UL listed in accordance with UL 1008 and be labeled in accordance with that standard's 1½ and 3 cycle, long time ratings. ATS's which are not tested and labeled with 1½ and 3 cycle (any breaker) ratings and have series, or specific breaker ratings only, are not permitted.

2.11 TESTS AND CERTIFICATION

- A. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings are in compliance.

2.12 SERVICE REPRESENTATION

- A. The ATS manufacturer shall maintain a national service organization of company employed personnel located throughout the contiguous United States. The service center's personnel shall be factory trained and shall be on call 24 hours a day, 365 days a year.
- B. The manufacturer shall maintain records of each switch, by serial number, for a minimum of 20 years.

PART 3 - EXECUTION

3.01 GENERAL

- A. Securely mount transfer switch.
- B. Provide power and control connections.
- C. Test for proper operation and adjust time delay relays to manufacturer's and/or the serving Utilities recommendations.

3.02 TRAINING

- A. Training on the project ATS's shall be for four (4) hours, minimum on site. The training sessions shall consist of two (2) separate, two (2) hour sessions at site.

3.03 SUPPLIES

- A. At Substantial Completion, Contractor shall furnish the following expendable items:

1. Twenty (20) percent spare fuses and lamps of each type furnished but not less than six (6) of each type.

END OF SECTION 26 36 00

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY

- A. This section describes the materials and installation requirements for Surge Protective Devices (SPDs).

1.02 REFERENCES AND QUALITY ASSURANCE:

- A. IEEE C62.41, C62.45-2002, and C62.62.
- B. National Electrical Manufacturers Association (NEMA LS1)
- C. National Fire Protection Association (NFPA 70)
- D. UL 1449
- E. UL 1449

1.03 SUBMITTALS

- A. For each SPD device, Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures including the following:
 - 1. Product Data Sheets in NEMA LS-1 format - Publication for Low Voltage Surge Protection Devices (SPDs).
 - 2. Electrical/mechanical drawings showing unit dimensions, weights, installation instructions details, and wiring configuration.
 - 3. UL 1449 Edition 3 Listing Certificate.
 - 4. UL 1449 Edition 3 Suppressed Voltage Ratings.
 - 5. Independent let through voltage test results to ANSI IEEE C62.41 Cat C3 high energy impulse (20kV,10kA), B3 ring wave (6kV, 3kA).
 - 6. Warranty statement establishing the terms and conditions.
 - 7. Independent certification shall be provided proving that the SPD meets a single shot surge rating of at least 300kA 8/20μs per phase, without failure of the fuse, disconnect or surge module. Bypassing of fusing/disconnects for purpose of this test is not acceptable.
 - 8. Noise Rejection testing as outlined in NEMA LS1-1992 (R2000) Section 3.11. Noise rejection shall be measured between 50kHz and 100MHz verifying the devices noise attenuation. Multiple attenuation levels over a range of frequencies shall be shown.
 - 9. Independent certification shall be provided proving that the type 2 SPD in a non-distribution panel meets a single shot surge rating of at least 120kA

- 8/20 μ s per mode, without failure of the fuse, disconnect or surge module. Bypassing of fusing/disconnects for purpose of this test is not acceptable.
10. Independent certification shall be provided proving that a type 2 SPD in a lighting panel meets a single shot surge rating of at least 60kA 8/20 μ s per phase, without failure of the fuse, disconnect or surge module. Bypassing fusing/disconnects for purpose of this test is not acceptable.

1.04 MANUFACTURES QUALIFICATIONS

- A. Manufacturers shall be ISO9000 certified.
- B. Manufacturers shall have been engaged in the design and manufacturing of such devices for at least ten (10) years.
- C. SPD shall be UL 1449 current edition listed, 20kA In Type 1 or Type 2 for use in UL 896A systems.
- D. Manufacturer:
1. ERICO Inc.
 2. Eaton
 3. Square D
 4. ABB
 5. Siemens

1.05 WARRANTY

- A. The manufacturer shall warrant the SPD against defects in material and workmanship for period of 10 years.

PART 2 - PRODUCTS

2.01 GENERAL ELECTRICAL REQUIREMENTS

- A. Unit operating voltage: Refer to drawings for operating system voltage.
- B. Maximum continuous operating voltage (MCOV): the MCOV shall not be less than 115% of the nominal system operating voltage.
- C. The suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create environmental hazards. End of life mode shall be open circuit. Unit with end of life short-circuit mode is not permitted.

- D. SPD shall include L-G, L-N, and N-G modes of protection for wye systems at minimum. Delta power systems shall include L-L and L-G modes of protection at minimum.
- E. Nominal Discharge Current (In): SPDs applied to the distribution system shall have a 20kA In rating regardless of their SPD Type (includes Types 1 and 2) or operating voltage.
- F. Electrical Noise Filter: Each Type 2 unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
 - 1. Type 2 units with filtering shall conform to UL 1283 5th Edition.
 - 2. Type 1 units shall not contain filtering or have a UL 1283 5th Edition Listing.
- G. Internal Connections - No plug-in single-mode modules or printed circuit boards shall be used as surge current conductors. Internal components shall be soldered and hardwired with connections utilizing low impedance conductors.
- H. Remote Status Monitor- The SPD shall include Form C dry contacts (one NO and one NC) for remote annunciation of its status. Both the NO and NC contacts shall change state under any fault condition. A reduction in capacity below the manufacturer's predetermined level shall operate an alarm contact.
- I. Surge Counter- The SPD shall be equipped with an LCD display that indicates how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of $50 \pm 20A$ occurs.
 - 1. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve functionality.

- J. The SPD shall have a maximum continuous operating voltage (MCOV) of:

POWER SYSTEM	MCOV (L-N)
Single phase (3W+G) 120/240 WYE	150V
Three phase (4W+G) 120/208 WYE	150V
Three phase (4W+G) 220/380 WYE	320V
Three phase (4W+G) 277/480 WYE	320V
Three phase (4W+G) 347/600 WYE	485V
Three phase (3W +/-G) 240V Delta	270V L-L
Three phase (3W +/-G) 480V Delta	550V

- K. The following Voltage Protection Rating (VPR) L-N, L-L For Delta, shall not be exceeded by the SPD:

Impulse Standard	120/240V	120/208V	220/380V	277/480V	240V Delta
ANSI/IEEE C62.41	<650V	<650V	<1000V	<1000V	<1000V
Cat B3	6kV	6kV	6kV	6kV	6kV
ANSI/IEEE C62.41	<1400V	<1400V	<1800V	<1800V	<1800V
Cat C3	20kV	20kV	20kV	20kV	20kV

2.02 SERVICE ENTRANCES, MAIN SWITCHBOARD AND MAIN BREAKER OR DISTRIBUTION PANEL (UL TYPE 1&2)

- A. Hard wired MOV type SPD shall be installed at AC service entrances of each building. Installation on equipment shall be integrated into the panel to reduce lead length.
- B. SPD shall be constructed with replaceable modules and shall not utilize pluggable connection, due to the possibility of such devices to “weld” in place at higher surge currents.
- C. SPD shall incorporate 300kA 8/20µs aggregate surge current per phase, min.
- D. Each mode of the SPD shall be rated to exceed the life cycle testing of ANSI/IEEE C62.45 by withstanding least 10,000 operations at 3kA 8/20µs without failure.
- E. SPD shall be internally line fused and be UL Listed for use on circuits with short circuit fault currents of 200 kA. The fuses shall be field replaceable with indication to warn if fuse has ruptured. Unit shall not require external fuses/breaker for connection.
- F. SPD shall be capable of withstanding multiple temporary over voltages per UL 1449 Ed 3 without failure or need to reset or replace modules/fuses.

2.03 NON SERVICE DISTRIBUTION PANELS (UL TYPE 2)

- A. Hard wired MOV type SPD shall be installed at all distribution panels, MCC's and/or as otherwise shown on the drawings. Installation on new equipment shall be integrated into the panel to reduce lead length.
- B. SPD shall be constructed with replaceable modules. However, they shall not utilize pluggable connection, due to the possibility of such devices to "weld" in place at higher surge currents.
- C. SPD shall incorporate 250kA 8/20 μ s aggregate surge current per phase, min.
- D. SPD shall incorporate 250kA 8/20 μ s aggregate surge current per phase, min.
- E. Each mode of the SPD shall be rated to exceed the life cycle testing of ANSI/IEEE C62.45 by withstanding at least 10,000 operations at 3kA 8/20 μ s without failure.
- F. SPD shall be internally line fused and be UL Listed for use on circuits with short circuit fault current rating (SCCR) of 200 kA. The fuses shall be field replaceable with indication to warn if fuse has ruptured. Unit shall not require external fuses/breaker for connection.
- G. SPD shall be capable of withstanding multiple temporary over-voltages per latest adopted UL 1449 edition without failure or need to reset or replace modules/fuses.

2.04 LIGHTING PANELS (UL TYPE 2)

- A. SPD shall be installed at additional specific locations as indicated on the panelboard schedules.
- B. SPD shall be capable of withstanding multiple temporary over voltage per UL 1449 Ed 3 without failure or need to reset or replace modules/fuses.
- C. SPD shall provide 120kA 8/20 μ s surge rating per phase, min.
- D. Each mode of the SPD shall be rated to exceed the life cycle testing of ANSI/IEEE C62.45 by withstanding at least 10,000 operations at 6kV and 500A B3 Ringwave without failure.
- E. SPD shall be internally line fused and be UL Listed for use on circuits with short circuit fault current rating (SCCR) of 200 kA. These fuses to be field replaceable with indication to warn if fuse has ruptured. Unit shall not require external fuses/breaker for connection.

- F. SPD shall be capable of withstanding multiple temporary over voltages per latest adopted UL 1449 edition without failure or need to reset or replace modules/fuses.

2.05 UL 508A TYPE CONTROL PANELS (UL TYPE 1 AND 2)

- A. Hard wired MOV type SPD shall be installed within all service entrance rated control panels, exterior mounted control panels and/or as otherwise shown on the drawings. Installation on new equipment shall be integrated into the panel to reduce lead length.
- B. SPD shall be constructed with replaceable modules. However, they shall not utilize pluggable / modular connection, due to the possibility of such devices to “weld” in place at higher surge currents.
- C. Each mode of the SPD shall be rated to exceed the life cycle testing of ANSI/IEEE C62.45 by withstanding least 10,000 operations at 3kA 8/20μs without failure.
- D. SPD shall be internally line fused and be UL Listed for use on circuits with short circuit fault currents of 100 kA. These fuses to be field replaceable with indication to warn if fuse has ruptured. Unit shall not require external fuses/breaker for connection.
- E. SPD shall be capable of withstanding multiple temporary over voltages per UL 1449 Ed 3 without failure or need to reset or replace modules/fuses.
- F. Manufacturers:
 - 1. Eaton CVX series
 - 2. ABB
 - 3. Square D Equal

PART 3 - EXECUTION

3.01 INSTALLATION

- A. SPDs shall be factory installed within the equipment.

END OF SECTION 26 43 00

DIVISION 31 EARTHWORK

SECTION 31 05 05
SITework DEMOLITION AND REMOVAL

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).

1.02 SUMMARY

- A. Section includes:
 - 1. The removal and satisfactory disposal of pavement materials including concrete pavement, asphalt pavement, concrete driveways, sidewalks, curb and gutter, aggregate base, and geotextile fabric.
 - 2. The removal and disposal of designated utility structures, pipes, and related appurtenances.
 - 3. The removal and disposal of existing chain link fence.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 11 13 - Work Covered by Contract Documents.
 - 2. Section 01 45 00 - Quality Control.
 - 3. Section 01 51 00 - Temporary Utilities.
 - 4. Section 01 56 00 - Temporary Barriers and Enclosures.
 - 5. Section 01 57 00 - Temporary Controls.

1.03 PROTECTION

- A. Confine Work and stockpiling to within designated areas on the City of Pierre property as approved by Engineer. Leave undisturbed all pavement and utility appurtenances not indicated for removal or renovation.
- B. Maintain proper positive drainage during construction operations and through completion.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Inspect and record existing conditions on site and at adjacent areas prior to starting construction.
- B. Become familiar with required lines of removal and saw cutting.
- C. Identify underground utilities.
- D. Provide, erect, and maintain adequate barriers and warning lights.
- E. Protect and maintain survey monuments or any construction staking from disturbance during pavement removal.
- F. Keep streets, sidewalks, alleys, and driveways in usable condition; avoid property owner inconvenience insofar as practicable; do not trespass on private property.
- G. Verify traffic control in place prior to commencement of pavement removal.
- H. Commencement of this Section's Work means acceptance of existing conditions.

3.02 REMOVAL

- A. Saw cutting is required on all concrete and asphalt pavements. Pavement removal beyond the limits established in the notes on the Drawings shall be replaced at the Contractor's expense.
- B. Saw cut vertically full depth to obtain a clean break. Remove on straight lines approximately parallel or perpendicular to centerline or pavement.
- C. Remove curb and gutter where indicated on Drawings, or as necessary to accomplish Contractor's work. All additional curb and gutter removal must be approved by Engineer and Owner. Curb and gutter removal not specified and without proper approval shall be replaced at the Contractor's expense.
- D. Disturbances, breakage, or damage to areas not designated for removal shall be restored at Contractor's expense prior to final payment.
- E. Pavement removed beyond the limits established shall be replaced to the same specifications as the adjacent removal at Contractor's expense.
- F. Remove entire width of sidewalk if replacement width is less than sidewalk width.
- G. Remove abandoned utility structures, pipes, and related appurtenances where indicated on the drawings or encountered by new construction. Fill trenches with Type S1 or S2 subsoil material, as specified in Section 31 05 13, and compact to a minimum of 95% of maximum dry density determined by ASTM D698 (Standard Proctor).

- H. Where abandoned pipes are to remain in place, plug all exposed ends with concrete.
- I. Where abandoned structures are to remain in place, plug all pipe penetrations with concrete and fill structure with Class 3 material, as specified in Section 31 05 16.

3.03 TOLERANCES

- A. Saw cut full depth of pavement to achieve a clean break. If required line of removal falls within 2 feet (60.96 cm) of an existing joint, adjust line of removal to be the existing joint.

3.04 DISPOSAL

- A. Remove broken pavement, pipes, utility structures, and appurtenances, and dispose of materials off site in Contractor furnished disposal area in a manner that is acceptable to local authorities and regulatory agencies.

END OF SECTION 31 05 05

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SECTION 31 05 13
SOILS FOR EARTHWORK

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System); 2017, with Editorial Revision (2020).
- C. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

1.02 SUMMARY

- A. Section includes:
 - 1. Subsoil materials.
 - 2. Topsoil materials.
- B. Related Sections include:
 - 1. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
 - 2. Division 1 – General Requirements Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.

1.03 SUBMITTALS FOR REVIEW

- A. See Section 01 33 00 - Submittal Procedures.
- B. Samples: In accordance with Section 01 45 00 - Quality Control.

1.04 QUALITY ASSURANCE

- A. Section 01 45 00 - Quality Control: Field Samples.
- B. Material Source: Provide materials from the same source throughout the Work. Change of source requires Engineer approval.

PART 2 - PRODUCTS

2.01 SUBSOIL MATERIALS

- A. Subsoil: Uncontaminated excavated on-site material or imported borrow material. Graded free of lumps larger than 3 inches (76.2 mm), rocks larger than 2 inches (50.8 mm), and debris; non-plastic and inorganic material.
 - 1. Type S1: Fine sand and gravel, including fine sands, sand-clay mixtures, and gravel-clay mixtures. Conforming to ASTM D2487 Group Symbol GM, GC, SM, SC, SP, SW, or dual symbol groups.
 - a. Type S1 gradation: 100% passing 2" sieve, 0% to 40% passing a #40 sieve, 0% to 10% passing a #200 sieve.
 - 2. Type S2: Silt, silty-clay, inorganic clays, and silts of low to medium plasticity and a maximum liquid limit of 40. Conforming to ASTM D2487 Group Symbol CH, CL, ML, or dual symbols thereof.
 - a. Inorganic on-site native soils are considered type S2 material.
 - 3. Type S3: Plastic to highly plastic clays and clay-silt materials of medium to high plasticity Conforming to ASTM D2487 Group Symbol CH, and MH or dual symbols thereof.
 - 4. Unsuitable soils: All frozen material, vegetation, trash, rocks, and concrete and bituminous chunks having a dimension exceeding 3 inches (76.2 mm) and otherwise not meeting the specifications of soil materials.

2.02 TOPSOIL MATERIALS

- A. Topsoil: Uncontaminated excavated on-site material or imported borrow material; Graded free of roots, rocks larger than ¾ inches, subsoil, debris, large weeds, and foreign matter.
 - 1. Type S4: Imported or Re-used; Friable loam. Acidity range (pH) of 5.5 to 7.5 containing a minimum of 4 percent and a maximum of 25 percent organic matter. Conforming to ASTM D2487 Group Symbol OL and OH.

2.03 SOURCE QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Testing and analysis of soil material.
- B. Testing and Analysis of Subsoil Material: Perform in accordance with ASTM D698 and ASTM D6938.
- C. Testing and Analysis of Topsoil Material: Perform in accordance with ASTM D2487.
- D. Provide materials of each type from same source throughout the Work.

PART 3 - EXECUTION

NOT USED.

END OF SECTION 31 05 13

SECTION 31 05 16
AGGREGATES FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).

1.02 SUMMARY

- A. Section includes:
 - 1. Aggregate materials for site uses, such as pipe bedding, base, and surface courses.
- B. Related Sections include, but are not limited to:
 - 1. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
 - 2. Division 1 – General Requirements Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.
 - 4. Division 32 – Exterior Improvements Specification Sections.
 - 5. Section 31 23 23 - Fill and Backfill.
 - 6. Section 31 23 33 - Trenching and Backfilling.
 - 7. Section 32 11 23 - Aggregate Base Courses.
 - 8. Section 32 13 13 - Concrete Pavement.
 - 9. Section 33 10 00 - Water Utilities.

1.03 SUBMITTALS FOR REVIEW

- A. Section 01 33 00 - Submittal Procedures: Procedures for submittals.
- B. Samples: Submit, in air-tight containers, 40 pound sample of each type of aggregate to testing laboratory. Submit Laboratory Results to Engineer.

1.04 QUALITY ASSURANCE

- A. Section 01 45 00 - Quality Control : Field Samples.
- B. Material Source: Submit name of imported material supplier(s). Provide materials from the same source throughout the Work. Change of source requires Engineer approval.

PART 2 - PRODUCTS

2.01 AGGREGATE MATERIALS

- A. Coarse Aggregate Type A1: Well graded crushed stone or gravel conforming to the requirements of ASTM C33, Gradation 67.
- B. Coarse Aggregate Type A2 (Gravel Surface): Gravel; Angular crushed or natural stone; free of shale, clay, friable material and debris; graded in accordance with South Dakota Department of Transportation referenced specifications, Section 882, Gravel Surfacing.
- C. Coarse Aggregate Type A3 (Aggregate Base Course): Gravel; Angular crushed or natural stone; free of shale, clay, friable material and debris; graded in accordance with South Dakota Department of Transportation referenced specifications, Section 882, Aggregate Base Course.
- D. Fine Aggregate Type A4 (Sand/Pipe Bedding): Natural river or bank sand; free of silt, clay, loam, friable or soluble materials, and organic matter; graded in accordance with ASTM C33, within the following limits:

Sieve Size	Percent Passing
3/8-in.	100
No. 100	0 to 10

- E. Gravity PVC/HDPE Sewer Pipe Bedding Aggregate: Type A4 (Sand/Pipe Bedding).
- F. RCP Storm Sewer Bedding Aggregate: Type A4 (Sand/Pipe Bedding).
- G. PVC Water Pipe Bedding Aggregate: Type A4 (Sand/Pipe Bedding).
- H. Manhole Bedding Aggregate: Type A3 (Aggregate Base Course).

2.02 SOURCE QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Source testing and analysis of aggregate material.
- B. Contractor shall submit samples, obtain laboratory results, and submit for Engineer's approval.
- C. Coarse Aggregate Material – Testing and Analysis: Perform in accordance with ASTM C136, ASTM D698 and ASTM D3017. Provide one test for each stockpile used, new test for every change in material.

- D. Fine Aggregate Material – Testing and Analysis: Perform in accordance with ASTM C136, ASTM D698 and ASTM D3017. Provide one test for each stockpile used, new test for every change in material.
- E. Aggregates Intended for Bedding or Backfill – Testing and Analysis: Perform moisture density relationship and moisture content testing in accordance with ASTM C136, ASTM D698 and ASTM D3017. Perform one test for each change in bedding or backfill material source.
- F. If tests indicate materials do not meet specified requirements, change material or material source and retest.
- G. Provide materials of each type from the same source throughout the Work.

PART 3 - EXECUTION

3.01 STOCKPILING

- A. Stockpile materials in accordance with Section 31 14 13.

3.02 STOCKPILE CLEANUP

- A. Cleanup stockpiles in accordance with Section 31 14 13.

END OF SECTION 31 05 16

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SECTION 31 14 13
SOIL STRIPPING AND STOCKPILING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Protection of features not designated for removal.
 - 2. Topsoil Removal.
 - 3. Stockpiling of Materials.
 - 4. Stockpile Cleanup.
- B. Related Sections include:
 - 1. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
 - 2. Division 1 – General Requirement Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.

1.02 DESCRIPTION

- A. Limits of construction are shown on the Drawings. Excavation shall not be allowed outside of the limits of construction where shown on the Drawings.
- B. Materials may be temporarily stockpiled on the site within the limits of construction or where shown on the Drawings.
- C. Protect benchmarks and existing structures that are to remain from damage or displacement.

1.03 FIELD MEASUREMENTS

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

1.04 DEFINITIONS

- A. Soil Testing Laboratory: Refers to a professional soils engineering firm with soil sampling and testing services that is independent from the CMAR.
- B. Structures: Existing and new construction, including slabs, buildings, footings, tanks, and other structural elements.

1.05 SITE CONDITIONS

- A. Geotechnical exploration was performed by American Engineering Testing, Inc. The Report of Preliminary Geotechnical Exploration and Review and the Report of Geotechnical Exploration and Review is included in this Project Manual.
- B. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the CMAR. The information is made available for the convenience of the CMAR and is in no way, shape, or form considered a part of this Contract.
- C. CMAR shall determine to their own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- D. CMAR may perform additional test borings or other exploratory operations at CMAR's own expense. CMAR shall make arrangements for any additional soils investigation with Owner.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 INSPECTION

- A. CMAR shall verify which native materials are suitable for reuse at the site. Provide testing data as required and keep materials separated.
- B. Notify Engineer of any unsuitable materials.

3.02 PROTECTION OF FEATURES NOT DESIGNATED FOR REMOVAL

- A. Protect all existing structures, trees, plantings, turf, and other facilities which are not scheduled for removal.

3.03 TOPSOIL REMOVAL

- A. Remove sod and grass and then excavate full depth of topsoil from areas to be further excavated, re-landscaped, or re-graded without mixing with foreign materials.
- B. All topsoil shall be stripped to full depth 12 inches (304.8 mm) minimum) and stockpiled separately in area of site designated by plan drawings or by Owner and Engineer. Topsoil will be available for replacement on top of finished grading and all disturbed areas not covered by structures or pavement.

- C. Separate all debris, large roots, and rocks greater than one (1) inch from the topsoil and remove from the site to CMAR furnished off-site disposal area.
- D. Do not excavate wet topsoil.
- E. Where trees are to be left standing, stop topsoil stripping a sufficient distance (at least the drip line) from a tree to prevent damage to main root system.
- F. Excavated topsoil shall remain Owner's property. Remove all excavated topsoil to stockpile area designated by CMAR and approved by the Owner and Engineer or shown on Drawings and stockpile to a depth not exceeding 8 feet (243.84 cm) and protect from erosion.

3.04 STOCKPILING OF MATERIALS

- A. CMAR may temporarily stockpile acceptable materials including topsoil, excess excavated material, and delivered materials within the limits of construction where shown on the Drawings. CMAR shall obtain approval from Owner and Engineer before stockpiling excess materials.
- B. Stockpile in sufficient quantities to meet Project schedule and requirements.
- C. Separate differing materials with dividers or stockpile apart to prevent mixing. Prevent intermixing of material types or contamination of stockpiled materials.
- D. Direct surface water away from stockpile site to prevent erosion or deterioration of materials.
- E. Apply appropriate erosion control measures to stockpile areas.
- F. CMAR shall remove all excess stockpiles from the site prior to substantial completion of the project.

3.05 STOCKPILE CLEANUP

- A. Remove stockpile; leave area in a clean and neat condition. Grade site surface to prevent freestanding surface water.
- B. If a borrow area is indicated, leave area in a clean and neat condition. Grade site surface to prevent freestanding surface water.
- C. Restore stockpile area in accordance with Section 32 92 19.

END OF SECTION 31 14 13

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SECTION 31 22 00
SITE GRADING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements and procedures for site grading including, but not limited to, the following:
 - 1. Rough Grading
 - 2. Finish Grading
 - 3. Topsoil Placement
- B. Related Sections include:
 - 1. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
 - 2. Division 1 – General Requirement Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.

1.02 DESCRIPTION

- A. Contractor shall grade the site as shown on the Drawings. Contours and spot elevations indicate finished surface grades.
- B. Construct uniform slopes between contours and spot elevations.
- C. Limits of construction are shown on the Drawings as indicated by the fencing boundary or property lines. Excavation, placement of fill, or general grading shall not be allowed outside of the limits of construction where shown on the Drawings.
- D. Materials may be temporarily stockpiled on the site within the limits of construction as designated by CMAR and approved by the Owner and Engineer or where shown on the Drawings.
- E. Topsoil removal and rough grading of the site shall be completed prior to commencement of structure construction.
- F. Perform finish grading and topsoil placement after structure shell and paving is completed.
- G. Protect benchmarks and existing structures that are to remain from damage or displacement.
- H. All earthwork shall be performed in a manner and sequence that will provide drainage and proper erosion control at all times.

1.03 FIELD MEASUREMENTS

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

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Subsoil and Topsoil Fills: As specified in Section 31 05 13.
- B. Aggregate Fills: As specified in Section 31 05 16.
- C. Provide source testing data in accordance with Section 01 45 00.

2.02 SOURCE QUALITY CONTROL

- A. Conduct the following tests on each material proposed for use prior to start of soils work. Refer to Section 01 45 00 for source test requirements.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify that survey benchmark and intended elevations for the Work are as indicated.
- B. Verify structure and trench backfilling have been inspected.
- C. Verify subgrade base has been contoured and compacted.

3.02 PREPARATION

- A. Identify required lines, levels, contours, and datum.
- B. Contractor shall be responsible for coordinating with all utility companies for location of buried utilities prior to excavation.
- C. Locate, identify, and protect all utilities that remain, from damage.
- D. Notify utility companies to remove and/or relocate utilities that interfere with construction.
- E. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- F. Protect benchmarks, survey control points, and existing structures, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

3.03 PROTECTION

- A. Contractor shall conduct all grading operations within the limits of construction where shown on the Drawings, and within the designated grading limits as shown from contours and spot elevations.
- B. Protect all existing structures, trees, plantings, turf, and other facilities which are not scheduled for removal
- C. Provide proper erosion and sediment control for all grading operation.
- D. Repair disturbed areas and compact to required density prior to further work.
- E. Remove material contaminated by erosion and runoff, provide new material and compact.

3.04 PREPARATION FOR TOPSOIL

- A. Eliminate uneven areas and low spots.
- B. Remove debris, roots, branches, and stones in excess of 2 inches (50.8 mm) in size. Remove subsoil contaminated with petroleum products.
- C. Scarify surface to depth of 3 inches (76.2 mm) where topsoil is scheduled. Scarify in areas where equipment used for hauling and spreading topsoil has compacted subsoil.

3.05 ROUGH GRADING

- A. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas. Smooth finish surface within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.
- B. Grade surface of fill under structures and slabs to required density, free of voids, and to required elevations.
- C. Rough grade areas adjacent to structure lines to drain away from structures and to prevent ponding or increase in soil lateral pressure on the structure.

3.06 FINISH GRADING

- A. Contractor shall provide the degree of finish grading that will be normally obtainable through the use of suitable equipment operated under favorable conditions and by an experienced operator. Deviations from the required tolerance shall be corrected by the Contractor at no additional cost to the Owner.

3.07 TOPSOIL PLACEMENT

- A. Place topsoil in areas where seeding and restoration is required to a minimum depth of 6 inches (152.4 mm). Place topsoil during dry weather.

- B. Use imported topsoil as a supplement to stockpiled topsoil only when a 6 inch (152.4 mm) depth is unable to be maintained.
- C. Drag topsoiled areas to remove wheel tracks and provide a uniform texture and appearance.
- D. Fine grade topsoil to eliminate rough or low areas. Maintain profiles and contour of subgrade. Finish grades shall allow for proper drainage without ponding.
- E. Remove roots, weeds, rocks, and foreign material while spreading.
- F. Manually spread topsoil close to plant life and buildings to prevent damage.
- G. Lightly compact placed topsoil.
- H. Contractor shall load, haul, and spread or stockpile all excess topsoil and subsoil materials in Owner furnished on-site disposal areas as directed by the CMAR and approved by Owner, and Engineer.
- I. Contractor shall furnish additional topsoil if sufficient quantity is not available on-site, including providing, transporting and placing topsoil.
- J. Leave stockpile area and site clean and raked, ready to receive landscaping.

3.08 TOLERANCES

- A. Top of Topsoil: Plus or minus 1 inch (25.4 mm).

3.09 SCHEDULE

- A. Fill to Correct Over-excavation:
 - 1. Fill Type A1 as specified in Section 31 05 16, compacted to 98% of Standard Proctor maximum dry density (ASTM D698).
- B. Subgrade Preparation and fill below paved and landscaped areas:
 - 1. Fill Type S1 or S2 as specified in Section 31 05 13, compacted to 98% of Standard Proctor maximum dry density (ASTM D698), and within +/- 3% of optimum moisture content.
 - 2. Lifts shall be no thicker than 9-inches prior to compaction. In the top 24-inches, lifts shall be no thicker than 6-inches.

END OF SECTION 31 22 00

SECTION 31 23 01
EARTHWORK FOR STRUCTURES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements and procedures for structural grading including, but not limited to, the following:
 - 1. Filling, Backfilling, and Compacting.
 - 2. Related Sections include, but are not limited to:
 - a. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
 - b. Project Geotechnical Report by American Engineering Testing, Inc.
 - c. Division 1 – General Requirements Specification Sections.
 - d. Division 31 – Earthwork Specification Sections.

1.02 RELATED REQUIREMENTS

- A. Sections Include:
 - 1. Section 31 05 13 - Soils for Earthwork.
 - 2. Section 31 05 16 - Aggregates for Exterior Improvements.
 - 3. Section 31 23 16 - Excavation.
 - 4. Section 31 23 19 - Dewatering.

1.03 DESCRIPTION

- A. Limits of construction are shown on the Drawings. Placement of fill shall not be allowed outside the boundary shown on the Drawings.
- B. Materials may be temporarily stockpiled on the site within the limits of construction as designated by CMAR and approved by Owner and Engineer or where shown on the Drawings.
- C. Excess materials shall be stockpiled on site at locations authorized by Owner.
- D. Protect benchmarks and existing structures that are to remain from damage or displacement.

1.04 DEFINITIONS

- A. Suitable Material: Material that will provide the indicated required soil bearing capacity, soil densities, material requirements or, in the opinion of the soils testing laboratory, will not be subject to future decomposition, subsidence, settlement, or expansion.

- B. Structures: Existing and new construction, including slabs, buildings, footings, tanks, and other structural elements.
- C. Relative Compaction:
 - 1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
 - 2. Optimum Moisture Content:
 - a. Determined in accordance with ASTM standard specified to determine maximum dry density for relative compaction.
 - b. Determine field moisture content on basis of fraction passing $\frac{3}{4}$ -inch sieve.
 - 3. Complete Course: A course or layer that is ready for next layer or next phase of Work.
 - 4. Lift: Loose (uncompacted) layer of material.
 - 5. Well-Graded:
 - a. A mixture of particle sizes with not specific concentration or lack thereof of one or more sizes.
 - b. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - c. Use to define material type that, when compacted, produces a strong and relative incompressible soil mass free of detrimental voids.
 - 6. Influence Area: Are within planes sloped downward and outward at 60-degree angle from horizontal measured from:
 - a. 1 foot (30.48 cm) outside outermost edge at base of foundations or slabs.
 - b. 1 foot (30.48 cm) outside outermost edge at surface of roadways or shoulder.
 - c. 0.5 foot (15.24 cm) outside exterior of spring line of pipes.
 - 7. Borrow material: Material from required excavations or from CMAR furnished borrow areas.
 - 8. Select Backfill Material: CMAR furnished materials suitable for intended use.
 - 9. Imported Material: Materials obtained and paid for by CMAR from sources offsite, suitable for specified use.

1.05 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

1.06 SITE CONDITIONS

- A. Geotechnical exploration was performed by American Engineering Testing, Inc. The Report of Preliminary Geotechnical Exploration and Review and the Report of Geotechnical Exploration and Review is included in this Project Manual.
- B. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the CMAR. The information is made available for the convenience of the CMAR and is in no way, shape, or form considered a part of this Contract.
- C. CMAR shall determine to their own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- D. CMAR may perform additional test borings or other exploratory operations at CMAR's own expense. CMAR shall make arrangements for any additional soils investigation with Owner.

1.07 SEQUENCING AND SCHEDULING

- A. Backfill against concrete structures only after concrete has attained compressive strength. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

1.08 FIELD MEASUREMENTS

- A. Verify that survey benchmark, control point, and intended elevations for the Work are as shown on Drawings or will be provided by the Engineer.
- B. FIELD QUALITY CONTROL
- C. Section 01 45 00 - Quality Control: Field inspection and testing.
- D. Compaction testing will be performed in accordance with ASTM D698, and ASTM D6938.
- E. If tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest at no additional cost to Owner.

1.09 COORDINATION

- A. Coordinate work under provisions of Section 01 31 13.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Backfill around and below Structures: Backfill shall be as indicated on the Construction Drawings. Structures shall utilize Type A3 materials as specified in Section 31 05 16 within and under all structures unless otherwise indicated.
- B. CMAR and subsequent contractors working in excavation areas shall furnish aggregate materials as necessary to provide a stable working surface for the installation of their work items.
- C. Flowable Fill shall meet the specifications of Controlled Density Fill (CDF) from Section 31 23 23.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Notify utility company to locate utilities.
- C. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities that are to remain.
- F. CMAR shall verify which native materials are suitable for reuse as backfill material at the site. Provide testing data as required and keep materials separated.
- G. Notify Engineer of any unsuitable materials or poor subgrade conditions.
- H. Dewater excavations during backfilling.
- I. Dewater and dry saturated materials suitable for backfill.
- J. Compact subgrade to density requirements for subsequent backfill materials.
- K. Cut out soft areas of subgrade not capable of compaction in-place. Backfill with Type A3 fill and compact to density equal to or greater than requirements for subsequent fill material.
- L. Identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.02 STOCKPILING OF MATERIALS

- A. Stockpile according to Section 31 14 13.

3.03 FILLING, BACKFILLING, AND COMPACTING

- A. Prepare subgrades according to specification 31 23 13 prior to installing fill material.
- B. Backfill areas to contours and elevations with unfrozen materials.
- C. Do not proceed with backfilling of excavations until completion of the following:
 - 1. Observation, testing, approval, and recording of locations of underground utilities.
 - 2. Removal of unsuitable materials, construction related debris, and excess materials.
 - 3. Placement and Compaction
 - a. Place materials in compacted layers of thickness required to obtain specified soil densities. Layers shall not exceed 9 inches (228.6 mm) in loose depth for cohesive and cohesionless soil material compacted by heavy compaction equipment and not more than 6 inches (152.4 mm) in loose depth for cohesive and cohesionless soil materials compacted by hand operated or remote-controlled tampers.
 - b. Place material in lifts uniformly to the same approximate elevation, not exceeding the final grade height, in manner required to prevent creation of unbalanced soil lateral pressures, wedging action of materials and soil pressures that exceed the design lateral soil conditions and to prevent damage to the structure.
 - c. Moisten or aerate each layer to the extent required to obtain the moisture content required for the indicated compaction density.
 - 1) Prevent free water from appearing on surface during or subsequent to compaction operations.
 - d. Remove and replace with acceptable material, or scarify and air dry otherwise acceptable soil material that is too wet to obtain specified soil density. Assist drying by disking, harrowing, or pulverizing, until moisture content is reduced to value required for compaction.
 - e. Compact each layer to the required density specified for each area classification. Hand tamp or utilize hand operated vibratory equipment when required to compact material placed in confined areas.
 - f. Do not place additional layers until density of each layer in place complies with compaction requirements. Perform corrective work as required to obtain required density.

3.04 PLACING FILL OVER GEOSYNTHETICS OR VAPOR RETARDER

- A. General:
 - 1. Place fill over geosynthetics with sufficient care so as not to damage them.

2. Place fill by back dumping and spreading only.
3. Dump fill only on previously placed fill.
4. While operating equipment, avoid sharp turns, sudden starts and stops that could damage geosynthetics.
5. Hauling: Operate hauling equipment with a minimum 2 feet (60.96 cm) of covering.
6. Spreading:
 - a. Spreading equipment shall be track mounted low ground pressure, D-3 or lighter.
 - b. Operate spreading equipment on minimum of 12-inches of fill.
 - c. Spread fill in same direction as unseamed overlaps to avoid separation.
 - d. Limit distance material falls to maximum of 2 feet (60.96 cm).
 - e. Flatten wrinkles in direction of spreading.
 - f. Maintain proper overlap of unseamed fabric.
 - g. Avoid overstressing material and seams.
7. Geosynthetics Damage:
 - a. Mark punctures, tears, or other damage, so repairs can be made.
 - b. Clear overlying fill as necessary to repair damage.
 - c. Repair with geosynthetic material placed to overlap a minimum of 2 feet (60.96 cm) on all sides of repaired area.

3.05 COMPACTION REQUIREMENTS

- A. Compact materials as required in Section 01 45 00 or shown in Schedule below.
- B. Recompect and retest all areas represented by failed density tests at CMAR expense.

3.06 TOLERANCES

- A. Finished Grade:
 1. Plus or minus 1 inch (25.4 mm) in ditches, berms, and lawn areas.
 2. Plus or minus 1 inch (25.4 mm) in roadways and driveways.

3.07 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 54 00.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.08 SCHEDULE

- A. Requirements based on finished surface areas:
 1. Beneath and adjacent to structures:
 - a. Material: As indicated on the Construction Drawings, Type A3 material per Section 31 05 16 placed in compliance with the Drawings.

- b. Compacted Thickness: Equal, continuous layers not exceeding 9 inches (228.6 mm) compacted thickness. In the upper 12 inches (304.8 mm) of soil below the finished subgrade place compacted lifts no greater than 6 inches (152.4 mm).
 - c. Compaction: Minimum 98% of standard proctor density (ASTM D698).
- 2. Fill at and for Over-excavation:
 - a. Fill Type A3 as specified in Section 31 05 16, as indicated on the Construction Drawings, to required elevation, compacted to a minimum 98% of standard proctor density (ASTM D698).
- 3. CMAR Stabilization and Working Surfaces:
 - a. Completed as per the means and methods. Provide no less than Fill Type A3 as specified in Section 31 05 16, compacted to a minimum 98% of standard proctor density (ASTM D698) if the surface is to remain below a finished structure.

END OF SECTION 31 23 01

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SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Scarifying, compacting and shaping the earth subgrade below pavements and structures.
2. Perform subgrade preparation on all areas to receive structures, concrete pavement, aggregate base course, and/or aggregate surface course.
3. Subgrade preparation is required only in areas of cohesive subgrade soils. In areas where select granular fill has already been installed to finished subgrade elevation, subgrade preparation shall not be required.

B. Related Sections:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
2. Division 1 – General Requirements Specification Sections.
3. Division 31 – Earthwork Specification Sections.

PART 2 - PRODUCTS

2.01 OTHER MATERIALS

- A. Provide other materials, not specifically described but required for a complete and proper installation, as selected by the Contractor subject to approval of the Engineer.
- B. Suitable Soil Materials: On-Site excavated material or imported material meeting subsoil classification S1 or S2, as defined in Section 31 05 13, free of rock or gravel larger than 2 inches (50.8 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

PART 3 - EXECUTION

3.01 GENERAL

- A. Subgrade Preparation shall consist of producing a firm and stable subgrade prior to placement of the surface or base course.

3.02 SUBGRADE PREPARATION

- A. The Contractor shall compact and shape the subgrade for its full width as may be necessary to produce, at the time the base course is placed, the required density in the upper 12-inches of the subgrade and the required grade and cross-section.
- B. The subgrade shall be prepared by scarifying the upper 12-inches of subgrade soil and compacting according to Section 31 23 23. Subgrade preparation shall extend deeper than 12-inches if the Engineer determines that additional subgrade preparation is necessary to support construction.
- C. The pavement subgrade shall be compacted to 98% of the maximum dry density. All soil materials shall be compacted according to Section 31 22 00. Subgrade preparation shall extend deeper if necessary to support construction.
- D. All subgrades below structures shall be inspected by the Owner's Geotechnical Engineer prior to placing any foundation materials.
- E. All subgrades below structures shall be cut to the final depth with a smooth-edged backhoe or other equipment that will minimize disturbance to the subgrades.
- F. If areas are encountered that cannot be compacted, sub-excavate unstable materials and replace with Type S1 soil materials that can be compacted.
- G. Contractor shall be responsible for drying the subgrade soil or applying water as may be necessary to obtain the required density. Contractor shall also be responsible for grading the Work area and providing drainage so that accumulating water will drain away from the subgrade.
- H. The finished subgrade surface shall be smooth and uniform and shall not rut, shove, flex, or displace when any construction equipment is placed on it, as demonstrated by satisfactory proof-rolling.
- I. The required grade and cross-section for subgrades shall consist of a smooth subgrade surface that conforms to the prescribed elevations for the particular subgrade being prepared, prior to constructing an additional course thereon. The required grade and cross-section for rough graded surfaces shall consist of a smooth graded surface that conforms to the prescribed elevations for that particular rough grade being prepared. The prescribed elevation for any point on the subgrade or rough graded surfaces shall be as determined from the grades indicated on the plans.
- J. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations, vehicular traffic, or weather conditions.

- K. Surface or base course and embankment fill shall not be placed on subgrades until the subgrade has been tested and Contractor has proven that the requirements specified herein have been met. Upon completion of a successful test, Contractor shall maintain the subgrade and repair any damage prior to placing subsequent materials.
- L. Subgrade preparation shall apply to all pipe trenches; concrete manholes; concrete slabs; paved and graveled areas; including roads, driveways, parking areas, sidewalks, and ramps.
- M. Testing requirements for subgrade preparation shall be as follows:
 - 1. Shall conform to requirements of Section 01 45 00.

3.03 TOLERANCES

- A. Finish subgrade or rough graded surfaces shall not deviate by more than 1 inch (25.4 mm) from the required section and grade.

END OF SECTION 31 23 13

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SECTION 31 23 16
EXCAVATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Requirements for Excavation.
 - 2. Common Excavation.
 - 3. Disposal.
- B. Related Sections:
 - 1. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
 - 2. Division 1 – General Requirements Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM).
- B. South Dakota Department of Transportation (SDDOT) Standard Specifications for Road and Bridge Construction, latest edition.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
 - 1. Test Results: Prior to start of work, submit written reports for each material sampled and tested. Include project identification, date of report, name of contractor, name of testing laboratory, source of material, manufacturer and brand name for manufactured products, specification requirements for each material, and corresponding test results.
 - a. Tests must have been taken no more than 180 calendar days before Notice to Proceed.
 - 2. Product Data: Information on manufactured products indicating compliance with requirements of this Section.

1.04 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.
- B. Acceptable Materials: Material that will provide for the indicated soil bearing capacity, soil densities, material requirements and that, in the opinion of soil

testing laboratory, will not be subject to future decomposition, settlement, subsidence, expansion and are otherwise of the required soil type.

- C. Unsuitable Materials: Material that will not provide for the indicated soil bearing capacity and soil densities and that in the opinion of the soil testing laboratory will be subject to future decomposition, settlement, subsidence, expansion, and are otherwise not of the required soil type.
- D. Soil Testing Laboratory: Refers to professional soils engineering firm with soil sampling and testing services and that is independent from the CMAR. The soil testing laboratory's engineer shall be licensed in the State of South Dakota.
- E. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, topsoil removal, excavation to grade, and scarification and compaction of subgrade.

1.05 SITE CONDITIONS

- A. Geotechnical exploration was performed by American Engineering Testing, Inc. The Report of Preliminary Geotechnical Exploration and Review and the Report of Geotechnical Exploration and Review is included in this Project Manual.
- B. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the CMAR. The information is made available for the convenience of the CMAR and is in no way, shape, or form considered a part of this Contract.
- C. CMAR shall determine to their own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- D. CMAR may perform additional test borings or other exploratory operations at CMAR's own expense. CMAR shall make arrangements for any additional soils investigation with Owner.

1.06 QUALITY ASSURANCE

- A. Source Quality Control Testing: Retain and pay for the services of an independent soil testing laboratory for Source Quality Control sampling and testing.
- B. Materials and installed work may require testing and retesting, as required by Engineer, at any time during progress of work.
- C. Allow free access of testing laboratory to material stockpiles and facilities at all times.

- D. Tests, including retesting of rejected materials and installed work, shall be at CMAR's own expense unless otherwise indicated.
- E. See Section 01 45 00 for additional requirements.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Stockpile delivered materials and excavated materials at locations approved by Owner until required for backfill or fill. Place, grade, and shape stockpiles for drainage.
- B. Store materials in manner that will not impose additional loading and soil pressure on excavation limits and structures.

1.08 FIELD MEASUREMENTS

- A. Survey benchmarks, control points, and intended elevations for the Work are as shown on the Drawings or will be provided by the Engineer.

1.09 COORDINATION

- A. Coordinate work under provisions of Section 01 31 13.
- B. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.
- C. CMAR shall excavate for structures, pipe, and utilities at grades shown on the Drawings. Careful consideration shall be given to whether elevations shown are invert elevations or centerline elevations, CMAR shall make appropriate adjustment depending on elevation shown.

PART 2 - PRODUCTS

2.01 EXCAVATION MATERIALS

- A. See Section 31 05 13 for materials specifications.

2.02 SOURCE QUALITY CONTROL

- A. See Section 31 23 23 and Section 01 45 00 for material quality testing requirements.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine project site and conditions under which work of this Section is to be performed.

- B. CMAR shall verify which native materials are suitable for reuse at the site. Provide testing data as required and keep materials separated.
- C. Notify Engineer of any unsuitable materials.
- D. Do not over excavate without authorization from Engineer.

3.02 PREPARATION

- A. An OSHA approved competent person shall review the soil classification in the field. Excavations shall comply with the requirements of OSHA 29 CFR, Part 2926, Subpart P, "Excavations and Trenches." Excavation safety is the responsibility of the CMAR. All excavations greater than 20 feet (609.6 cm) in depth shall be designed by a registered Professional Engineer.
- B. Dry subgrade: Add water, then mix to make moisture content uniform throughout.
- C. Wet subgrade: Aerate material by blading, disking, harrowing, or other methods to hasten drying process.

3.03 PROTECTION

- A. Locate existing utilities in areas of work. Protect utilities that are to remain.
- B. Protect structures from damage and from damage caused by groundwater, surface water, flood or floatation forces, lateral movement, settlement, undermining, washout, and other undesirable conditions created by the work.
 - 1. Maintain drainage when drainage ways are obstructed by earthwork and related operations.
- C. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, except when allowed by utility owner and then only after acceptable temporary utility services have been provided.
 - 1. Provide temporary services, complying with Federal, State and local laws and regulations, and as acceptable to Owner, during any interruptions.
- D. Protect areas that have been finish graded from subsequent construction operations, traffic, and erosion.
 - 1. Install erosion control protection along perimeter of unfinished areas.
- E. Maintain full access to structure exits and entrances, fire hydrants, street crossings, sidewalks, and other points designated by Owner to prevent significant interruption of accessibility.
- F. Maintain excavations and stockpiles to prevent caving, heaving, slides, and increased soil pressures on adjacent and underlying structures.

- G. Repair disturbed areas and compact to required density prior to further work.
- H. Remove material contaminated by erosion and runoff, provide new material and compact.
- I. Maintain existing site drainage ways or provide new paths of drainage for site as required to perform earthwork.

3.04 COMMON EXCAVATION

- A. Excavate designated areas to the proposed subgrade elevations indicated on the Drawings.
- B. CMAR shall advise Engineer immediately if any unsuitable materials are encountered during excavation. Unsuitable materials shall be reasonably separated from suitable materials and shall be considered excess material for disposal by the CMAR.
- C. If CMAR encounters excess excavation materials which meet the requirements of common fill as specified herein, CMAR may use those materials as common fill. CMAR shall verify with soils testing laboratory suitability of the use of on-site material.
- D. Excavating shall be done in accordance with Section 31 23 33.
- E. Prior to the placement of engineered fill or construction of structures, any loosened granular materials shall be surface compacted using a vibratory plate compactor. In areas where groundwater is within 3 foot (91.44 cm) of the subgrade this requirement may be waived in the field by the Engineer if it is found the compaction is pumping up water or creating a temporary "quick" condition and the soils are otherwise suitable for support of the foundations. Areas that yield or pump during surface compaction may require additional subcutting.

3.05 DISPOSAL

- A. Excess soil, if any exists, shall be disposed of by the CMAR. CMAR shall remove unsuitable material such as organic matter, trash, and refuse from the site and dispose of said material according to applicable Federal, State, and local regulations in CMAR furnished off-site disposal area.

END OF SECTION 31 23 16

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SECTION 31 23 19
DEWATERING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing, installing, operating, maintaining, and removing temporary dewatering systems required to maintain excavations, trench bottoms, structure subgrades, and work areas in a dry and stable condition during construction.
2. Collection, conveyance, treatment, and disposal of surface water and groundwater encountered during construction.
3. Protection of excavations, structures, utilities, pavements, and adjacent facilities from hydrostatic pressure, flotation, settlement, erosion, or instability resulting from dewatering operations.
4. Related Sections:
 - a. Division 01 – General Requirements
 - b. Division 02 – Existing Conditions
 - c. Division 31 – Earthwork
 - d. Division 40 – Process Interconnections

1.02 SUBMITTALS

A. Provide submittals in accordance with the requirements of Section 01 33 00.

B. Dewatering Plan:

1. Submit a detailed Dewatering Plan to the Engineer a minimum of seven (7) days prior to beginning excavation or dewatering activities.
2. Dewatering Plan shall be prepared and sealed by a Professional Engineer licensed in the State of South Dakota
3. Dewatering Plan shall include, but not be limited to:
 - a. Description of proposed dewatering methods.
 - b. Pump capacities and standby equipment
 - c. Estimated pumping rates and anticipated duration of dewatering activities.
 - d. Location of pumps, wellpoints, discharge piping, sediment control devices, and discharge locations.
 - e. Measures for maintaining excavation stability and protecting adjacent structures and utilities.
 - f. Measures to prevent migration of fines and disturbance of subgrade materials.
 - g. Proposed methods for treatment and disposal of discharge water.
 - h. Erosion and sediment control measures.

- i. Contingency procedures for equipment failure or unanticipated groundwater conditions.
- j. Procedures for removal and abandonment of temporary dewatering systems.

1.03 SYSTEM DESCRIPTION

- A. The dewatering system shall be of a sufficient size and capacity to:
 - 1. Lower the groundwater level to a minimum of two (2) feet below:
 - a. The lowest foundation subgrade level.
 - b. The lowest pipe trench bottom.
 - c. Lower the hydrostatic head below any excavation to the extent that the hydrostatic head in the construction area is a minimum of two (2) feet below the prevailing excavation surface.
 - d. Allow work to be performed in the dry.
 - e. Control, by acceptable means, all water regardless of source.
 - f. Maintain adequate control of water so the stability of excavated and constructed slopes is not adversely affected.
 - 2. The dewatering system shall be designed using accepted and professional methods of design and engineering consistent with the best modern practice. The dewatering system shall include deep wells, wellpoints, and other equipment, appurtenances, and related earthwork necessary to perform the function. A representative of the CMAR shall visit the site to determine the conditions thereof. The CMAR shall be responsible for the accuracy of the Drawings and design data required hereinafter.
- B. Dewatering operations shall not adversely impact:
 - 1. Existing wastewater treatment operations
 - 2. Existing tanks or structures
 - 3. Adjacent utilities or buried piping
 - 4. Existing pavements or roadways
 - 5. Nearby property or drainageways.

1.04 QUALITY ASSURANCE

- A. Review by the Engineer of the Drawings and design data submitted by the CMAR shall not in any way be considered to relieve the CMAR from full responsibility for errors therein or from the entire responsibility for complete and adequate design and performance of the system in controlling the water level in the excavated area and for control of the hydrostatic pressure to depths hereinbefore specified.
- B. The CMAR shall be solely responsible for proper design, installation, proper operation, maintenance, and any failure of any component of the system.

1.05 SITE CONDITIONS

- A. Geotechnical exploration was performed by American Engineering Testing, Inc. The Report of Preliminary Geotechnical Exploration and Review and the Report of Geotechnical Exploration and Review is included in this Project Manual after Section 02 32 00.
- B. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the CMAR. The information is made available for the convenience of the CMAR and is in no way, shape, or form considered a part of this Contract.
- C. CMAR shall determine to CMAR's own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- D. CMAR may perform additional test borings or other exploratory operations at CMAR's own expense. CMAR shall make arrangements for any additional soils investigation with Owner.

1.06 PERMITS AND LICENSES

- A. The CMAR shall be responsible for obtaining all necessary permits as related to dewatering and water discharge and to comply with all stipulations of such permits.
- B. Dewatering shall not be initiated until after the dewatering plan has been approved and reviewed by the Engineer and the CMAR has received all necessary permits.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 GENERAL

- A. Each excavation shall be kept dry during the course of all work herein, including subgrade preparation, pipe installation, and backfilling, to the extent that no damage from hydrostatic pressure, flotation, or other damage results. All excavations shall be dewatered to a depth of at least two (2) foot below the bottom of the exposed surface, the concrete base, or pipe to be installed herein.
- B. The CMAR may use any method or combination of methods for dewatering, provided that those methods are consistent with all other provisions contained in the Specifications; however, all dewatering methods and equipment, which, in the opinion of the Engineer, are ineffective at either dewater the site or treating

dewatering discharge, shall be abandoned, improved, replaced or otherwise altered to obtain effective dewatering.

- C. The CMAR shall provide all power, pumps, materials, and equipment necessary, and shall be responsible for disposing of the water pumped from the excavation in a manner, which will not interfere with other Work within the area and will not damage public or private property. The CMAR will be held responsible for the condition of any pipe, conduit, ditch, channel or natural watercourse utilized for drainage purposes. All erosion, sediment or other adverse results of its use shall be repaired at CMAR's expense.
- D. CMAR shall provide suitable means of standby power to keep dewatering system fully operational.

3.02 CORRECTIVE ACTION

- A. The CMAR shall be responsible for, and shall repair without cost to the Owner, any damage to work in place, other CMARs' equipment, and the excavation, including damage to the bottom due to heave and including removal of material and pumping out of the excavated area that may result from CMAR's negligence, inadequate or improper design and operation of the dewatering system, and any mechanical or electrical failure of the dewatering system.
- B. CMAR shall install appropriate best management erosion control measures and maintain them as required.

3.03 WATER QUALITY CONTROL

- A. All points of concentrated dewatering discharge shall be visually inspected daily by the CMAR to determine that any sediment draining out of the construction site is consistent with all applicable permits and regulations.

3.04 REMOVAL

- A. Prior to removal of the system, insure compliance with regulatory permits.
- B. All wells shall be plugged in accordance with all applicable regulations.
- C. Shut off dewatering system at such a rate to prevent quick upsurge of water which may weather underlying subgrade or surrounding soil.

END OF SECTION 31 23 19

SECTION 31 23 23
FILL AND BACKFILL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements and procedures for site grading including, but not limited to, the following:
 - 1. Filling, Backfilling, and Compacting.
 - 2. Related Sections include, but are not limited to:
 - a. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
 - b. Division 01 – General
 - c. Division 31 – Earthwork

1.02 REFERENCES

- A. South Dakota Department of Transportation Standard Specification for Roads and Bridges, latest edition

1.03 DESCRIPTION

- A. Limits of construction are shown on the Drawings. Placement of fill shall not be allowed outside the boundary shown on the Drawings.
- B. Materials may be temporarily stockpiled on the site within the limits of construction as designated by Engineer or where shown on the Drawings.
- C. Excess materials shall be stockpiled on an area designated by the CMAR and approved by the Owner and Engineer or as shown on the Drawings.
- D. Protect benchmarks and existing structures that are to remain from damage or displacement.

1.04 DEFINITIONS

- A. Suitable Material: Material that will provide the indicated required soil bearing capacity, soil densities, material requirements or, in the opinion of the soils testing laboratory, will not be subject to future decomposition, subsidence, settlement, or expansion.
- B. Structures: Existing and new construction, including slabs, buildings, footings, tanks, and other structural elements.
- C. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D698.
- D. Optimum Moisture Content:
- a. Determined in accordance with ASTM standard specified to determine maximum dry density for relative compaction.
 - b. Determine field moisture content on basis of fraction passing $\frac{3}{4}$ -inch sieve.
- E. Complete Course: A course or layer that is ready for next layer or next phase of Work.
- F. Lift: Loose (uncompacted) layer of material.
- G. Well-Graded:
- a. A mixture of particle sizes with not specific concentration or lack thereof of one or more sizes.
 - b. Does not define numerical value that must be placed on coefficient of uniformity, coefficient of curvature, or other specific grain size distribution parameters.
 - c. Use to define material type that, when compacted, produces a strong and relative incompressible soil mass free of detrimental voids.
- H. Influence Area: Are within planes sloped downward and outward at 60-degree angle from horizontal measured from:
- a. 1 foot (30.48 cm) outside outermost edge at base of foundations or slabs.
 - b. 1 foot (30.48 cm) outside outermost edge at surface of roadways or shoulder.
 - c. 0.5 foot (15.24 cm) outside exterior of spring line of pipes.
- I. Borrow material: Material from required excavations or from CMAR furnished borrow areas.
- J. Select Backfill Material: CMAR furnished materials suitable for intended use.
- K. Imported Material: Materials obtained and paid for by CMAR from sources offsite, suitable for specified use.

1.05 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth); 2023.

1.06 SITE CONDITIONS

- A. Geotechnical exploration was performed by American Engineering Testing, Inc. The Report of Preliminary Geotechnical Exploration and Review and the Report of Geotechnical Exploration and Review is included in this Project Manual.
- B. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the Contractor. The information is made available for the convenience of the CMAR and Contractor and is in no way, shape, or form considered a part of this Contract.
- C. CMAR and Contractor shall determine to their own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- D. CMAR and/or Contractor may perform additional test borings or other exploratory operations at CMAR or Contractor's own expense. CMAR and Contractor shall make arrangements for any additional soils investigation with Owner.

1.07 SEQUENCING AND SCHEDULING

- A. Backfill against concrete structures only after concrete has attained compressive strength. Obtain Engineer's acceptance of concrete work and attained strength prior to placing backfill.

1.08 FIELD MEASUREMENTS

- A. Verify that survey benchmark, control point, and intended elevations for the Work are as shown on Drawings.

1.09 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Field inspection and testing.
- B. Compaction testing will be performed in accordance with ASTM D698 and ASTM D6938.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest at no additional cost to Owner.

1.10 COORDINATION

- A. Coordinate work under provisions of Section 01 31 13.
- B. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.

- C. CMAR shall excavate for piping and utilities at grades shown on the Drawings. Careful consideration shall be given to whether elevations shown are invert elevations or centerline elevations, CMAR shall make appropriate adjustment depending on elevation shown.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Backfill around Structures: Backfill shall be as indicated on the Construction Drawings. Structures shall utilize Type S1 materials as specified in Section 31 05 13 within and under all structures unless otherwise indicated as granular materials which are specified in Section 31 05 16.
- B. Flowable Fill/Controlled Density Fill shall meet the specifications of Section 31 23 23.

2.02 CONTROLLED DENSITY FILL

- A. CMAR shall furnish and provide Controlled Density Fill (CDF) material to be used at locations shown on drawings and where more stable bedding and backfill material is needed where settlement must be minimized.
- B. CDF material shall be a blend of cement, water, pozzolanic materials, and fillers. The material shall be fluid during placement and absent of voids. The material shall be able to support normal loads after six hours and shall have a compressive strength range of 75 psi (517.11 kPa) to 250 psi (1723.69 kPa) at 28 days. The material once cured shall be easily removed with a tractor backhoe.
- C. CMAR shall provide mix design and compression strength test results of the material to Engineer for approval prior to placement. Mix design may be altered to decrease flowability to enable forming of CDF material where needed.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Notify utility company to locate utilities.
- C. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- D. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- E. Maintain and protect above and below grade utilities that are to remain.

- F. CMAR shall verify which native materials are suitable for reuse as backfill material at the site. Provide testing data as required and keep materials separated.
- G. Notify Engineer of any unsuitable materials or poor subgrade conditions.
- H. Dewater excavations during backfilling.
- I. Dewater and dry saturated materials suitable for backfill.
- J. Compact subgrade to density requirements for subsequent backfill materials.
- K. Cut out soft areas of subgrade not capable of compaction in-place. Backfill with Type S1 fill and compact to density equal to or greater than requirements for subsequent fill material.
- L. Identify soft spots; fill and compact to density equal to or greater than requirements for subsequent fill material.

3.02 STOCKPILING OF MATERIALS

- A. Stockpile according to Section 31 14 13.

3.03 FILLING, BACKFILLING, AND COMPACTING

- A. Prepare subgrades according to specification section 31 23 13 prior to installing fill material.
- B. Backfill areas to contours and elevations with unfrozen materials.
- C. Proof roll subgrade areas below pavements, or where specifically noted with, as a minimum, a tandem axle dump truck loaded to at least 25 ton weight. Loose or soft soils shall be defined as soils exhibiting "excessive rutting" from the truck tires (approximately one (1) inch wheel rut depth).
- D. Systematically backfill to allow maximum time for natural settlement. Do not place material on loose, wet, muddy, spongy or frozen ground or on materials containing frost or ice.
- E. Slope grade away from structures minimum 2 inches (50.8 mm) in 10 feet (304.8 cm), unless noted otherwise.
- F. Do not proceed with backfilling of excavations until completion of the following:
 - 1. Observation, testing, approval, and recording of locations of underground utilities.
 - 2. Removal of unsuitable materials, construction related debris, and excess materials.
 - 3. Placement and Compaction

- a. Place materials in compacted layers of thickness required to obtain specified soil densities. Layers shall not exceed 9 inches (228.6 mm) in loose depth for cohesive and cohesionless soil material compacted by heavy compaction equipment and not more than 6 inches (152.4 mm) in loose depth for cohesive and cohesionless soil materials compacted by hand operated tampers.
- b. Place material in lifts uniformly to the same approximate elevation, not exceeding the final grade height, in manner required to prevent creation of unbalanced soil lateral pressures, wedging action of materials and soil pressures that exceed the design lateral soil conditions and to prevent damage to the structure.
- c. Moisten or aerate each layer to the extent required to obtain the moisture content required for the indicated compaction density. Prevent free water from appearing on surface during or subsequent to compaction operations.
- d. Remove and replace with acceptable material, or scarify and air dry otherwise acceptable soil material that is too wet to obtain specified soil density. Assist drying by disking, harrowing, or pulverizing, until moisture content is reduced to value required for compaction.
- e. Compact each layer to the required density specified for each area classification. Hand tamp or utilize hand operated vibratory equipment when required to compact material placed in confined areas.
- f. Do not place additional layers until density of each layer in place complies with compaction requirements. Perform corrective work as required to obtain required density.

3.04 PLACING FILL OVER GEOSYNTHETICS

A. General:

1. Place fill over geosynthetics with sufficient care so as not to damage them.
2. Place fill by back dumping and spreading only.
3. Dump fill only on previously placed fill.
4. While operating equipment, avoid sharp turns, sudden starts and stops that could damage geosynthetics.
5. Hauling: Operate hauling equipment with a minimum 2 feet (60.96 cm) of covering.
6. Spreading:
 - a. Spreading equipment shall be track mounted low ground pressure, D-3 or lighter.
 - b. Operate spreading equipment on minimum of 12-inches of fill.
 - c. Spread fill in same direction as unseamed overlaps to avoid separation.
 - d. Limit distance material falls to maximum of 2 feet (60.96 cm).
 - e. Flatten wrinkles in direction of spreading.
 - f. Maintain proper overlap of unseamed fabric.
 - g. Avoid overstressing material and seams.

7. Geosynthetics Damage:
 - a. Mark punctures, tears, or other damage, so repairs can be made.
 - b. Clear overlying fill as necessary to repair damage.
 - c. Repair with geosynthetic material placed to overlap a minimum of 2 feet (60.96 cm) on all sides of repaired area.

3.05 COMPACTION REQUIREMENTS

- A. Compact materials as required in Section 01 45 00 or shown in Schedule below.
- B. Recompect and retest all areas represented by failed density tests at CMAR expense.

3.06 TOLERANCES

- A. Finished Grade:
 1. Plus or minus 1 inch (25.4 mm) in ditches, berms, and lawn areas.
 2. Plus or minus 1 inch (25.4 mm) in roadways and driveways.
 3. All areas that receive fill or backfill shall be kept within settlement tolerances through the warranty period.

3.07 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 54 00.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.08 SETTLEMENT

- A. The CMAR shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from the Engineer or Owner, or sooner if required by Engineer or Owner, depending on the critical nature of the settlement.

3.09 SCHEDULE

- A. Requirements based on finished surface areas:
 1. Landscape area: Type S2, to a minimum of 6 inches (152.4 mm) below finish grade, compacted to minimum 90% of standard proctor density (ASTM D698).
 2. Beneath aggregate surfaces, adjacent to concrete structures, and for all pipe installations:
 - a. Material: As indicated on the Construction Drawings, Type S1 or S2 material per Section 31 05 13 unless otherwise indicated as granular material per Section 31 05 16 placed in compliance with the Drawings.
 - b. Compacted Thickness: Equal, continuous layers not exceeding 9 inches (228.6 mm) compacted thickness. In the upper 12 inches

- (304.8 mm) of soil below the finished subgrade place compacted lifts no greater than 6 inches (152.4 mm).
- c. Compaction: Minimum 98% of standard proctor density (ASTM D698).
- 3. Fill to Correct Over-excavation:
 - a. Fill Type S1 as specified in Section 31 05 13, or granular material as specified in Section 31 05 16 as indicated on the Construction Drawings, to required elevation, compacted to a minimum 98% of standard proctor density (ASTM D698).
 - 4. Base Preparation:
 - a. As indicated on the Construction Drawings, Fill Type S1 as specified in Section 31 05 13, compacted to a minimum 98% of standard proctor density (ASTM D698).
 - 5. Beneath Paved Roadways:
 - a. Compact Subsoil to a minimum 98% of standard proctor density (ASTM D698).
 - b. As indicated on the Construction Drawings, Fill Type S1.
 - c. Place Geotextile fabric as specified in Section 31 34 19 and cover with Fill Type A3, as shown in the Drawings, compacted to a minimum of 98% of standard proctor density (ASTM D698).
 - 6. Pipe Trenches:
 - a. See Section 31 23 33.
 - 7. Topsoil Fill:
 - a. See Section 31 05 13.

END OF SECTION 31 23 23

SECTION 31 23 33
TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Excavating trenches for utilities.
 - 2. Compacted bedding and fill of utilities to subgrade elevations.
 - 3. Backfilling and compaction requirements for trenches.
- B. Related Sections include, but are not limited to:
 - 1. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
 - 2. Division 1 – General Requirements Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.

1.02 DEFINITIONS

- A. Utility: Any buried pipe, duct, conduit, or cable.
- B. Soil Testing Laboratory: Refers to a professional soils engineering firm with soil sampling and testing services that is independent from the CMAR.
- C. Suitable Material: Material that will provide the indicated required soil bearing capacity, soil densities, material requirements or, in the opinion of the soils testing laboratory, will not be subject to future decomposition, subsidence, settlement, or expansion.
- D. Structures: Existing and new construction, including slabs, buildings, footings, tanks, and other structural elements.

1.03 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM D2922 - Standard Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth); 2010.

1.04 SITE CONDITIONS

- A. Geotechnical exploration was performed by American Engineering Testing, Inc. The Report of Preliminary Geotechnical Exploration and Review and the Report of Geotechnical Exploration and Review is included in this Project Manual.
- B. Data indicated on the subsurface conditions are not intended as representations, warranties of accuracy, or continuity between soil borings. It shall be expressly understood that Owner and Engineer shall not be responsible for interpretations or conclusions drawn from these reports by the CMAR. The information is made available for the convenience of the CMAR and is in no way, shape, or form considered a part of this Contract.
- C. CMAR shall determine to their own satisfaction the nature and location of subsurface obstacles and the nature of soil and water conditions which will be encountered during the work.
- D. CMAR may perform additional test borings or other exploratory operations at CMAR's own expense. CMAR shall make arrangements for any additional soils investigation with Owner.

1.05 FIELD MEASUREMENTS

- A. Verify that survey benchmark, control point, and intended elevations for the Work are as shown on Drawings.

1.06 COORDINATION

- A. Coordinate work under provisions of Section 01 31 13.
- B. Verify work associated with lower elevation utilities is complete before placing higher elevation utilities.
- C. CMAR shall excavate for piping and utilities at grades shown on the Drawings. Careful consideration shall be given to whether elevations shown are invert elevations or centerline elevations, CMAR shall make appropriate adjustment depending on elevation shown.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Granular materials provided for foundation, bedding, encasement, and backfill or other purposes shall consist of any natural or synthetic mineral aggregate such as sand, gravel, crushed rock, or slag, which shall meet the gradation requirements specified herein for each specific use.
- B. Granular materials provided for foundation, bedding, encasement, or backfill use shall be classified by use in accordance with the following requirements.

2.02 GRANULAR FOUNDATION

- A. Granular foundation shall be placed below the bottom of the pipe invert as replacement for unsuitable or unstable soils to provide better pipe support.
- B. Granular foundation material shall be A3 aggregate material as specified in Section 31 05 16.

2.03 GRANULAR BEDDING

- A. Granular bedding shall be placed below the pipe midpoint, prior to pipe installation to facilitate proper shaping and achieve uniform pipe support. Minimum depth as indicated on the Construction Drawings.
- B. Granular bedding material shall meet the requirements of Section 31 05 16 and as indicated on the Construction Drawings.

2.04 GRANULAR ENCASEMENT

- A. Granular encasement shall be placed below an elevation of six (6) inches above the top of the pipe, after pipe installation, for protection of the pipe.
- B. Granular encasement material shall be the same as granular bedding material and shall meet the requirements of Section 31 05 16 and as indicated on the Construction Drawings.

2.05 GRANULAR BACKFILL

- A. Granular backfill shall be used entirely between pipes crossing at different elevations and shall meet the requirements of Section 31 05 16 and as indicated on the Construction Drawings.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, maintain, and protect utilities that remain from damage.
- C. Notify utility company to locate utilities.
- D. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- E. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.
- F. Maintain and protect above and below grade utilities that are to remain.

- G. CMAR shall verify which native materials are suitable for reuse as granular foundation, bedding, encasement, and backfill material at the site. Provide testing data as required and keep materials separated.
- H. Notify Engineer of any unsuitable materials.
- I. Dewater trench and structure excavations.

3.02 EXCAVATING

- A. Excavate topsoil in accordance with Section 31 14 13.
- B. Excavate trench to alignment and grade as required to meet foundation and bedding requirements as specified. Trench shall be centered on pipe alignment and no more than 100 feet (3048 cm) of trench should be excavated in advance of pipe laying operations. Limit length of total open trench to 300 feet (9144 cm)
- C. Prevent inflow of surface water into trench and dewater the excavation as needed to prevent accumulation of groundwater during pipe installation.
- D. The trench width may vary and depend on the depth of trench, the diameter of pipe to be laid, and the nature of the material to be excavated, but in any case shall be of ample width to allow the pipe to be laid and joined properly and the backfill to be placed and compacted properly. The minimum bottom width of unsheeted trench shall be 18 inches (457.2 mm). The maximum clear width of trench at the top of the pipe shall be not more than 32 inches (812.8 mm) greater than the outside diameter of the pipe for pipes 30 inches (762 mm) diameter and larger, or 18 inches greater for pipe under 30 inches in diameter. Wider trench widths at the top of the pipe shall be subject to approval by Engineer. The width of the trench at the ground surface shall be kept to a minimum.
- E. If the trench width at the pipe zone is excavated to a greater width than the maximum, the Engineer may require the CMAR to provide a higher class of bedding and/or higher strength pipe that that required by the Contract Documents in order to satisfy pipe design requirements. In such case, no additional compensation shall be made for the higher class bedding or higher strength pipe.
- F. Trench excavation shall be made by open cut methods. Trench sides shall be as vertical as possible and the trench shall be braced, sheeted, and drained such that the work may be performed safely in accordance with OSHA requirements.
- G. Sheet piling, shoring, and bracing shall be put in place and maintained as required due to soil stability or site constraints. Shoring, sheet piling, and bracing shall be provided to prevent disturbance or settlement of adjacent surfaces, structures, foundations, utilities and other properties. Any damage to the work under contract or to existing adjacent structures or other improvements caused by

settlement, water or earth pressures, slides, cave-ins, or other causes due to lack of appropriate sheeting, shoring, or bracing shall be repaired at the CMAR's expense at no delay.

- H. Trench sheeting, shoring, and bracing shall be kept in place until pipe has been laid, tested for defects, and repaired if necessary, and the earth around the pipe is compacted. The sheeting, shoring, and bracing shall be removed in such a manner as not to remove the constructed pipe or adjacent structures or other improvements.
- I. It shall be the CMAR's responsibility for proper and adequate placement of sheeting, shoring, and bracing in accordance with all applicable regulations and standards.
- J. Whenever unsuitable or unstable soil for properly supporting the pipe or structures is encountered, a further depth and/or width shall be excavated and replaced with the foundation material specified herewith or other suitable foundation material and thoroughly compacted to assure a firm foundation for the pipe.
- K. Stockpile excavated material in an orderly manner, at sufficient distance from the trench to avoid overloading, to prevent slides and cave-ins.
- L. CMAR shall advise Engineer immediately if any unsuitable materials are encountered during excavation. Unsuitable materials shall be separated from suitable materials and shall be disposed of in Owner furnished on-site disposal area.
- M. If CMAR encounters excess excavation materials which meet the requirements of common fill, CMAR may use those materials as fill in common execution and fill areas. Excess materials shall be disposed of in Owner furnished on-site disposal area.
- N. Remove unsuitable materials in accordance to the depth recommended by the soils testing laboratory beneath structures to obtain desired soil bearing capacity. CMAR shall notify Engineer prior to any additional excavation that is needed. Additional excavation shall be subject to approval by the Engineer.
- O. Removal of materials beyond required subgrade elevations or dimensions without specific approval from soils testing laboratory and Engineer as well as backfilling, compaction, and other work at the over excavated area shall be at the CMAR's expense.
- P. Excavating and backfilling shall not be conducted in water. All excavations shall be maintained in a well drained condition at all times. CMAR shall provide and maintain temporary drainage facilities as required, and as approved by the Engineer, at no additional cost to the Owner.

- Q. Do not interfere with 45 degree bearing splay of foundations. Underpin adjacent structures, as necessary, to prevent damage by excavation Work.
- R. Hand trim for bell and spigot pipe joints. Remove loose matter.
- S. Remove lumped subsoil, boulders, and rock up to 1/3 cubic yard, measured by volume.
- T. In the event of shrinkage of excavated soils, resulting in shrinkage of backfill along trenches, CMAR shall provide, haul, place, and compact suitable soil type S1 or S2 from source at no cost to Owner.
- U. Stockpile excavated material in an orderly manner, at sufficient distance from the trench to avoid overloading, to prevent slides and cave-ins. Remove excess material not being used to Owner furnished on-site disposal area.

3.03 PIPE FOUNDATION

- A. Whenever unsuitable or unstable soil for properly supporting the pipe or structures is encountered, a further depth and/or width shall be excavated and replaced with the foundation material specified herewith or other suitable foundation material and thoroughly compacted to assure a firm foundation for the pipe.
- B. Additional density testing may be required in unstable areas where unsuitable materials are found. Engineer shall determine stability of trench bottom.
- C. Trench bottom shall be cut true and even so that the barrel of the pipe will have a bearing over the full length. Bell holes shall be excavated to ensure the pipe is resting for its entire length on the bottom of the trench and required bedding.

3.04 BACKFILLING

- A. Pipe Zone
 - 1. Should the materials available within the trench section be unsuitable or insufficient for this portion of the granular bedding, encasement and backfill materials as defined in this Specification, CMAR shall provide an approved material that meets the appropriate specifications.
 - 2. Backfill materials shall be placed with care and deposited uniformly on both sides of pipe throughout the entire trench width in maximum 9-inch lifts. Mechanically compact material to required densities.
 - 3. Flexible pipe shall be bedded in accordance with ASTM Specification D2321, "Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe." This shall include the placement of granular bedding and encasement materials from a point four (4) inches below the

bottom of the pipe to a point six (6) inches above the top of the pipe compacted to required densities.

4. Placement and compaction of bedding, encasement, and backfill materials shall be consider incidental to the installation of the pipe.

B. Above Pipe Zone

1. Use suitable excavated materials from the site prior to importing of select granular borrow material. Any additional suitable select granular borrow material required to be imported shall be provided by the CMAR at no additional cost to the Owner. CMAR shall separate unsuitable materials. Excess and unsuitable materials shall be properly disposed of by CMAR.
2. Place backfill materials in uniform layers no more the 8 inches (203.2 mm) loose depth. Mechanically compact each layer of material to required densities.
3. Do not backfill unless approved compaction equipment is operating. The method of means of placement and type of compaction equipment used is at the discretion of the CMAR, however, all portions of the trench backfill must meet the compaction requirements. Tests to determine the compacted density of the backfill may be ordered by the Engineer if the compaction does not appear to be adequate.

C. Backfill trenches to contours and elevations with unfrozen fill materials.

D. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

E. Aggregate Fill: Place and compact materials in equal continuous layers not exceeding 9 inches (228.6 mm) loose depth.

F. Soil Fill: Place and compact material in equal continuous layers not exceeding 9 inches (228.6 mm) loose depth.

G. Employ a placement method that does not disturb or damage utilities in trench. Prevent floatation of pipe.

H. Maintain optimum moisture content of fill materials to attain required compaction density. Use vibratory or special compaction equipment when required.

I. Remove surplus fill materials for disposal in Owner furnished on-site disposal area.

J. Leave fill material stockpile areas completely free of excess fill materials. CMAR shall have the responsibility to load, haul, and spread all excess fill in on-site disposal area.

3.05 COMPACTION REQUIREMENTS

- A. Compact according to a minimum of 98% of standard proctor density (ASTM D698).
- B. Recompact and retest all areas represented by failed density tests.

3.06 TOLERANCES

- A. Top Surface of Backfilling:
 - 1. Plus or minus 1 inch (25.4 mm), upon completion of settlement in ditches, berms, and lawn areas.
 - 2. Plus or minus 1 inch (25.4 mm) upon completion of settlement in roadways and driveways.
- B. Trenches shall be kept within settlement tolerances through the warranty period.

3.07 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Field inspection and testing.
- B. Compaction testing will be performed in accordance with ASTM D698, and ASTM D2922.
- C. If tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest at no additional cost to Owner.

3.08 PROTECTION OF FINISHED WORK

- A. Protect finished Work under provisions of Section 01 54 00.
- B. Reshape and re-compact fills subjected to vehicular traffic during construction.

3.09 SCHEDULE

- A. Raw Water Force Main, Finished Water Pipeline, and Gravity Piping:
 - 1. Pipe bedding; Fill type as specified for pipe material from bottom of excavation to elevation as shown on Construction Details.
 - 2. Cover pipe and bedding as scheduled in Section 31 05 13 and 31 05 16.

END OF SECTION 31 23 33

SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)); 2012 (Reapproved 2021).
- B. ASTM D4751 - Standard Test Methods for Determining Apparent Opening Size of a Geotextile; 2021a.

1.02 SUMMARY

- A. Prevention of sedimentation of waterways, wetlands, and storm and sanitary sewers due to construction activities.
- B. Restoration of areas eroded due to insufficient preventative measures.
- C. Related Sections include, but are not limited to:
 - 1. Division 02 – Existing Conditions
 - 2. Division 31 – Earthwork

1.03 REFERENCES

- A. References include:
 - 1. ASTM D 4355 – Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture, and Heat in a Xenon Arc Type Apparatus; 2005.
 - 2. ASTM D 4491 – Standard Test Methods for Water Permeability of Geotextiles by Permittivity; 1999a (Reapproved 2004).
 - 3. ASTM D 4533 – Standard Test Method for Trapezoid Tearing Strength of Geotextiles; 2004.
 - 4. ASTM D 4632 – Standard Test Method for Grab Breaking Load and Elongation of Geotextiles; 1991 (Reapproved 2003).
 - 5. ASTM D4751 – Standard Test Method for Determining Apparent Opening Size of a Geotextile; 2004.
 - 6. ASTM D 4873 – Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples, 2002.
 - 7. General Permit Authorization to Discharge Storm Water Associated with Construction Activity under the National Pollutant Discharge Elimination System/State Disposal System Permit Program.
 - 8. DOT: <https://dot.sd.gov/doing-business/environmental/stormwater/>

9. DANR: <https://danr.sd.gov/OfficeOfWater/SurfaceWaterQuality/>

1.04 SUBMITTALS

- A. Provide product specification sheets for the following erosion control materials to demonstrate that the CMAR's proposed products meet the Contract Document requirements:
1. Fabric proposed for silt fence
 2. Fabric proposed for inlet protection
 3. Inlet protection products, such as storm inlet sediment filters
 4. Erosion Control Blanket
 5. Gradation tests for Construction Entrance stone material

1.05 PERFORMANCE REQUIREMENTS

- A. Comply with all requirements of the South Dakota Department of Environment and Natural Resources – Surface Water Quality Program.
- B. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained.
1. CMAR may be required to co-sign on SWPP Permit obtained by Owner. Review SWPP with Owner and Engineer prior to submittal for approval.
- C. Timing: Put preventative measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.
- D. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
1. Control movement of sediment and soil from temporary stockpiles of soil.
 2. Prevent development of ruts due to equipment and vehicular traffic.
 3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.
- E. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.
1. Prevent windblown soil from leaving the project site.
 2. Prevent tracking of mud onto public roads outside of the site.
 3. Prevent mud and sediment from flowing onto sidewalks and pavements.
 4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

- F. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
 - 2. If sediment basins are used as temporary preventative measures, pump dry and remove deposited sediment after each storm.
- G. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
 - 1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
- H. Open Water: Prevent standing water that could become stagnant.
- I. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

PART 2 - PRODUCTS

2.01 SILT FENCE

- A. Geotextile Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:
 - 1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested with ASTM D4751.
 - 2. Permittivity: 0.05 sec^{-1} , minimum when tested in accordance with ASTM 4491.
 - 3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D 4355 after 500 hours exposure.
 - 4. Tensile Strength: 100 lb-f, minimum, in cross-machine direction; 124 lb-f, minimum, in machine direction; when tested in accordance with ASTM D 4632.
 - 5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D 4632.
 - 6. Tear Strength: 55 lb-f., minimum when tested in accordance with ASTM D 4533.
 - 7. Color: Manufacturer's standard.
- B. Posts: 5 feet (152.4 cm) long:

1. Steel T-section, with minimum mass of 1.26 lb per linear foot.

2.02 STORM SEDIMENT FILTER

- A. Shall be one of the following.

1. Sandbags.
 - a. Woven, polypropylene fabric sewn together with double stitching.
 - b. Overall sandbag size shall be at least 12 x 24 inches (609.6 mm).
 - c. Bags shall be filled ½ full with sand.
2. Drop-in Sediment Trap.
 - a. Geotextile Fabric unit that inserts into the inlet.
 - b. Shall be:
 - 1) Dandy Sack by Dandy Products, Inc.
 - 2) Siltsack by ACF Environmental.
 - 3) Approved Equivalent.

2.03 EROSION BALES:

- A. Erosion bales shall consist of hay or straw bales free of weeds with a nominal size of 15" x 18" x 48".
- B. Erosion bale anchors shall be 2" x 2" x 3' wood pegs.

2.04 CONSTRUCTION ENTRANCE

- A. Materials:

1. As Shown on Drawings.

- B. 3 – 6-inch Stone

1. Stone shall be angular and shall be comprised of hard, durable mineral materials that have been mechanically processed.
2. Stone gradation shall conform to the following:

Sieve	Percent Passing (by Weight)
6-Inch	100
3 1/2-Inch	50 - 100
3-Inch	10 - 75
2-Inch	0 - 10
3/8 Inch (9.52 Mm)	0 - 1

2.01 SLOPE EROSION PROTECTION SHALL BE ONE OF THE FOLLOWING

- A. Erosion Control Blanket.

1. Shall consist of a uniform web of interlocking fibers sandwiched between an attached top and bottom layer of net backing meeting the requirements of Section 734 of the South Dakota Department of Transportation Standard Specifications for Roads and Bridges, current edition.
2. The netting shall be biodegradable containing sufficient UV stabilization for breakdown to occur within a normal growing season.
3. Staples used to anchor the blankets shall be U-shaped, 11 gauge or heavier steel wire having a span width of 1 inch (25.4 mm) and a length of 8 inches (203.2 mm) or more from top to bottom after bending.
4. The erosion control blankets acceptable for use on this project include:
 - a. Propex, LLC. – Landlok S2.
 - b. North-American Green – SC150BN.
 - c. Or equal.

B. Bonded Fiber Matrix. (BFM)

1. The fibers shall be composed of 100% wood or wood by-products. A minimum of 25% of the fibers shall average 10.16 mm 0.4 inches (10.16 mm) in length and 50% or more shall be retained on a Clark Fiber Classifier 24 mesh screen. Fibers shall be colored with a water soluble, non-toxic dye, to aid in uniform application over the site.
2. The binder shall be a hydro colloid based (guar gum) with added slow-release and agricultural based fertilizers. The binder shall not dissolve or disperse upon rewetting.
3. The BFM slurry shall dry to form a crust approximately 3-0.24 inches (6 mm) thick adhering to the soil surface.
4. The moisture content of the matrix shall be 12% +/- 3% by weight.
5. The matrix shall consist of materials that are 100% biodegradable and 100% beneficial to plant life.
6. The installation rate of the BFM shall be 3,500 lbs per acre, minimum.
7. The matrix shall provide 100% continuous coverage and shall have no holes greater than 0.04 inch (1 mm) in size.
8. The hydrated matrix density shall be approximated by a slump test prior to application.
9. The BFM mulch: water ratio shall be as per the manufacturer recommendations. The minimum BFM mulch to water ratio is 50 lbs. BFM mulch and 100 gallons water. The water rate will vary between 100 gallons and 125 gallons per 50 lbs., depending on which of the products is used.
10. The Bonded Fiber Matrix mulch products acceptable for use on this project include:
 - a. HydraCM – Manufactured by Tensar North American Green
 - b. EcoAegis – Manufactured by CANFOR.
 - c. Soil Guard – Manufactured by Mat, Inc.

- d. ConWed 3000 – Manufactured by ConWed Fibers, Inc.
- C. Fiber Roll
 - 1. Fiber rolls shall consist of hay or straw free of noxious weeds, or wood excelsior that has been compressed and stuffed into degradable netting.
 - 2. The roll diameter shall be a minimum of six inches.
 - 3. All weighted fiber rolls shall contain a weighted core with a minimum weight of eight pounds per foot.

PART 3 - EXECUTION

3.01 EXAMINATION

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

3.02 PREPARATION

- A. The erosion control plan shall be provided by the CMAR. CMAR shall obtain associated City and State construction permits for construction and the Storm Water Pollution Prevention Plan (SWPPP). The CMAR is responsible for the methods and means required for implementing and all construction activities are to be in compliance with permits listed in the SWPPP. Erosion control is incidental to the GMP.

3.03 SCOPE OF PREVENTITIVE MEASURES

- A. Vehicle Tracking Pad at Construction Entrances: Traffic-bearing aggregate surface and metal grate, as shown on Construction Details.
 - 1. Width: As required; 24 feet (731.52 cm), minimum.
 - 2. Length: 50 feet (1524 cm), minimum.
 - 3. Provide at each construction entrance from public right-of-way.
 - 4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.
- B. Natural vegetation shall be retained whenever feasible.
- C. Land grading and excavating shall be kept at a minimum to reduce the possibility of creating runoff and erosion problems which require extensive control measures.
- D. Land exposure shall be minimized in terms of area and time.
- E. Silt Fence.

1. Provide along the perimeter edge of soil stockpiles located on the Owner's property.
 2. Provide at locations shown on the Plans.
- F. Storm Sediment Filters.
1. Place immediately after new storm sewer inlets are installed and immediately before land is disturbed adjacent to existing storm sewer inlets.
- G. Slope Erosion Protection.
1. Place at locations shown in the Plans.
- H. Fiber Roll
1. Place at locations shown in the Plans.

3.04 PERFORMANCE REQUIREMENTS

- A. CMAR shall comply with all requirements of the South Dakota Department of Environment and Natural Resources along with all Federal, State, and Local permits and regulations for erosion and sediment control.
1. If erosion or sedimentation occurs due to non-compliance with any of these permits, CMAR shall restore eroded areas at no cost to Owner.
 2. If sedimentation beyond permitted thresholds occurs in regulated waterways or wetlands, CMAR shall at no additional cost to the Owner:
 - a. Contact the authorities having jurisdiction;
 - b. Remove deposited sediments to the satisfaction of the Owner and the authorities having jurisdiction;
 - c. Install or correct preventive measures to the satisfaction of the authorities having jurisdiction; and
 - d. Pay any fines or other additional requirements of the authorities having jurisdiction; and
 - e. Meet the Contract schedule for project completion.
- B. CMAR shall not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.
1. Obtain and pay for permits and provide security required by authority having jurisdiction.

3.05 INSTALLATION

- A. Vehicle Tracking Pad.

1. The rock area shall be a minimum of 6 inches (152.4 mm) deep, extend the full width of the ingress/egress area and be at least 50 ft long; however, longer entrances may be required to adequately clean tires.
 2. Geotextile fabric may be used to prevent migration of mud from the underlying soil into the rock.
 3. Metal grate, as shown in Construction Details
- B. Storm Sediment Filters.
1. Sandbags.
 - a. Place around inlet providing a minimum of 12 inch (304.8 mm) horizontal clearance.
 - b. Place a minimum of 3 bags in height with staggered joints.
 2. Drop-in Sediment Trap.
 - a. Place as recommended by the manufacturer.
- C. Slope Erosion Protection.
1. Bonded Fiber Matrix (BFM).
 - a. The CMAR shall install the BFM as per the manufacturer's instructions with the following minimum guidelines:
 - 1) The BFM shall be applied with hydraulic spray equipment by a manufacturer's certified applicator.
 - 2) Application shall be done at least 24 hours in advance of projected rainfall to allow the BFM mulch adequate time to dry.
 - 3) The BFM mulch shall be applied into two stages (one-half rate) with ample time to dewater the first application.
 - 4) The BFM mulch shall be applied from at least two alternate directions, preferably 90 degrees apart if possible, to ensure all soil faces are covered.
 - 5) The installation rate of the BFM mulch shall be 3500 lbs per acre, minimum and 100% continuous coverage.
 - 6) After the BFM mulch is applied and dried for 24 to 48 hours, the Owner's Representative will sample and quantify a portion of the installation to ensure the minimum 3500 lbs per acre has been applied. If it is found that the desired 3500 lbs per acre has not been achieved, the CMAR shall apply an additional amount to equal the desired 3500 lbs per acre within 48 hours of receiving the test results. The CMAR will not be paid extra mobilization costs for spraying additional material.
 2. Erosion Control Blanket.

- a. The CMAR shall install the blanket as per the manufacturer's instructions with the following minimum guidelines:
 - 1) The CMAR shall roll out or lay the blankets parallel to the direction of water flow.
 - 2) The blankets shall be spread evenly without stretching and so the fibers are in direct contact with the soil over the entire area.
 - 3) Adjacent strip edges shall overlap each other at least 4 inches (101.6 mm).
 - 4) Strip ends shall overlap each other at least 7 inches (177.8 mm).
 - 5) All overlaps shall be made with the upgrade strip placed over the down grade strip intervals.
 - 6) The CMAR shall bury the upgrade end of each blanket strip at least 6 inches (152.4 mm) in a vertical slot in the soil with the soil being pressed firmly against the embedded blanket.
 - 7) All joints and outer edges of the blanket shall be stapled at 3 foot (91.44 cm) intervals or less.
 - 8) Staples placed at junctures and strip ends shall have a maximum spacing of 16 inches (406.4 mm).
 - 9) Staples shall be placed throughout the blanket at a maximum spacing of 3 feet (91.44 cm).
 - 10) All staples shall be inserted flush with the ground surface.

D. Silt Fences:

1. Store and handle fabric in accordance with ASTM D 4873.
2. Install with top of fabric at nominal height and embedment indicated on drawings.
3. Do not splice fabric width; minimize splices in fabric length; splice at post only, overlapping at least 18 inches (457.2 mm), with extra post.
4. Fasten fabric to steel posts using "U" shaped clips.

E. Fiber Roll:

1. Each fiber roll shall be overlapped by 1 foot (30.48 cm) minimum and tied tightly together, to prevent flow between the fiber roll ends.
2. Fiber rolls shall be trenched and staked according to manufacturer's specifications.

3. Six inch fiber rolls shall be used for sheet flow protection on backslopes and foreslopes.
4. 12 to 20-inch fiber rolls shall be used in ditch bottoms and in areas where shallow concentrated flow is present.

3.06 MAINTENANCE

- A. Inspect preventative measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (12.7 mm) or more rainfall at the project site, and daily during prolonged rainfall.
 1. All inspections and maintenance conducted during construction shall be recorded in writing and retained in accordance with the storm water permit.
- B. All removed tree material shall become the property of the CMAR and shall be disposed of off-site in CMAR furnished disposal area.
- C. All stumps and roots shall be removed to a minimum of 3 feet (91.44 cm) below grade.
- D. Backfill excavation with suitable on-site soil materials or engineered fill compacted to a minimum of 98% of Standard Proctor Density, ASTM D698.
- E. Silt Fences:
 1. Promptly replace fabric that deteriorates unless need for fence has passed.
 2. Remove silt deposits that exceed one-third of the height of the fence.
 3. Repair fences that are undercut by runoff or otherwise damaged, whether by runoff or other causes.
- F. Fiber Rolls:
 1. Sediment deposits shall be removed when the deposit reaches half the height of the fiber roll or when directed by the Engineer.
 2. Fiber rolls shall remain in place until the vegetative cover is restored to 70 percent of the preexisting vegetation.

3.07 CLOSE-OUT

- A. CMAR shall file a Notice of Termination with the State following site stabilization that meets the requirements of the General Permit.

- B. CMAR shall remove and clean up all temporary erosion and sediment control practices as shown on the Drawings. Site disturbance caused by removal of these practices shall be restored consistent with the surface restoration requirements shown on the Drawings. Costs for restoration shall be at CMAR's expense.

END OF SECTION 31 25 00

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SECTION 31 34 19
GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Woven Geotextile Fabric.
 - 2. Non-Woven Geotextile Fabric
- B. Related Sections include, but are not limited to:
 - 1. Section 01 33 00 - Submittal Procedures.
 - 2. Section 01 45 00 - Quality Control.
 - 3. Section 31 22 00 - Site Grading.
 - 4. Section 31 37 00 - Riprap.
 - 5. Section 32 11 23 - Aggregate Base Courses.

1.02 REFERENCES

- A. Reference Standards include, but are not limited to:
 - 1. South Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
 - 2. ASTM D3786 – Mullen Burst.
 - 3. ASTM D4355 – UV-Resistance.
 - 4. ASTM D4491 – Permittivity.
 - 5. ASTM D4595 – Wide Width Tensile Strength.
 - 6. ASTM D4632 – Grab Tensile Strength and Elongation.
 - 7. ASTM D4751 – Apparent Opening Size (AOS).
 - 8. ASTM D4833 – Puncture and Trapezoid Tear.
 - 9. ASTM D4873 – Guide for Identification, Storage, and Handling of Geosynthetics

1.03 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Provide product data on Geotextile Fabric.
- C. Submit manufacturer's installation instructions. Indicate special procedures and conditions requiring special attention.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. The geotextile rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement.
- B. Rolls shall be stored in a manner which protects them from the elements. At no time shall the geotextile be exposed to ultraviolet light for a period exceeding fourteen days.
- C. The geotextile rolls shall be labeled as per ASTM D 4873, "Guide for Identification, Storage, and Handling of Geosynthetics".

PART 2 - PRODUCTS

2.01 MATERIAL

- A. Woven fabric for reinforcement applications: Geotextile fabric shall be a woven fabric as specified in Section 831 of the South Dakota Department of Transportation Standard Specifications for use beneath pavement and aggregate base. Mirafi 600X, LINQ GTF 300, or approved equal are also approved as woven fabrics.
- B. Non-woven fabric for separation or rip rap applications: Geotextile fabric shall be non-woven fabric as specified in Section 831 of the South Dakota Department of Transportation Standard Specifications for use as a separation fabric between fine soils and rock riprap, or in other separation or drainage applications.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify subgrade has been inspected, gradients and elevations are correct; surface is dry, and ready to receive Work.

3.02 PREPARATION OF SUBSOIL

- A. Correct irregularities in subgrade gradient and elevation by scarifying a minimum of 6-inches, reshaping, and re-compacting.
- B. Do not place on soft, muddy, or frozen surfaces.

3.03 PLACEMENT

- A. The geotextile shall be laid out smooth without wrinkles or folds on the prepared subgrade in the direction of the construction traffic.
- B. Adjacent geotextile rolls shall be overlapped a minimum of 2.5 feet (76.2 cm), ends of rolls shall be overlapped 3 feet (91.44 cm).

- C. On curves, the fabric may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and shall be held in place by staples, pins or aggregate piles.
- D. Damaged areas shall be repaired by overlaying the area with sufficient material to overlap on all edges by at least 2.5 feet (76.2 cm).
- E. The aggregate base material shall be placed by end dumping onto the geotextile from the edge or over previously placed base aggregate. Construction equipment shall not be allowed directly on the geotextile fabric.
- F. A minimum of 12" of aggregate must be placed on the geotextile prior to the movement of construction equipment above the fabric.
- G. Turning movements must be carefully monitored to avoid rutting of the aggregate. Any ruts occurring during construction shall be filled with additional gravel aggregate and compacted to the specified density.
- H. If placement of the backfill causes damage to the geotextile, the damaged area shall be repaired as described in Section 3.03.D.
- I. Install geotextile fabric and aggregate base material beneath areas of pavement, other site surfacing as shown on typical sections, or indicated on drawings.

3.04 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control.

END OF SECTION 31 34 19

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SECTION 31 37 00
RIPRAP

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Rock Riprap.

B. Related Sections include, but are not limited to:

1. Section 31 22 00 - Site Grading.
2. Section 31 34 19 - Geotextile Fabric.

1.02 REFERENCES

A. Reference Standards include, but are not limited to:

1. ASTM C136 – Method for Sieve Analysis of Fine and Coarse Aggregates.
2. South Dakota State Highway Department Standard Specifications for Road and Bridge Construction, Section 830.1, latest edition.
3. ASTM D5519 – Particle Size.

1.03 QUALITY ASSURANCE

- A. Damage to the prepared surface shall be repaired at the Contractor's expense.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Riprap – Sound, durable field stone or quarry stone; solid and nonfriable; not made of sandstone, shale, or soft limestone; not salvaged concrete debris; not easily abraded or crushed; size range as indicated on drawings for intended use. Well graded within specified size range, so as to form a dense matrix without voids. Multiple size ranges are required for this project.
- B. Geotextile Fabric – Non-Woven Separator Fabric as specified in Section 31 34 19.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify subgrade has been inspected, gradients and elevations are correct, subgrade is dry, and is ready to receive work.

3.02 RIPRAP PLACEMENT

- A. Do not place riprap or fabric over frozen or spongy subgrade surfaces.
- B. Riprap shall not be dropped onto the geotextile from a height of more than 1 foot (30.48 cm). Any geotextile damaged during Rip Rap placement shall be replaced or repaired as specified in Section 31 34 19.
- C. Rock may be placed by mechanical means, but hand placement shall also be used as necessary to provide a uniform layer of riprap.
- D. The laying of stone on sloped areas shall begin at the toe of the slope. The riprap shall be thoroughly compacted as the construction progresses and the finished surface shall present an even, tight surface. Gaps shall be filled with smaller stones.
- E. Rock shall be distributed evenly over the riprap area without pockets of segregated sizes of stone. The rock shall be rearranged by manual or mechanical means if placement methods result in pockets of segregated size of stone.
- F. The finished surface of riprap area shall present an even distribution of stone sizes over the entire riprap area with no one area of any size deviating by more than 4 inches (101.6 mm).
- G. Schedule:
 - 1. Installed Riprap Thickness: Minimum thickness as indicated on drawings.
 - 2. Size Range: Within size range indicated on drawings for intended use.

END OF SECTION 31 37 00

DIVISION 32 EXTERIOR IMPROVEMENTS

SECTION 32 11 23
AGGREGATE BASE COURSES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes general requirements and procedures for furnishing and installing base and surfacing courses, including:
 - 1. Aggregate Base Course.
- B. Related Sections include, but are not limited to:
 - 1. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
 - 2. Division 1 – General Requirement Specification Sections.
 - 3. Division 31 – Earthwork Specification Sections.
 - 4. Division 32 – Exterior Improvements.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
- B. American Concrete Institute (ACI)
- C. American Society for Testing Materials (ASTM)
- D. SDDOT Standard Specifications for Roads and Bridges, latest edition
- E. ASTM D698 – Test Methods for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 5.5 lb Rammer and 12 inch (304.8 mm) Drop.
- F. ASTM D2167 – Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
- G. ASTM D2922 – Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
- H. ASTM D3017 – Test Methods for Moisture Content of Soil and Soil-Aggregate in place by Nuclear Methods (Shallow Depth).

1.03 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures.
- B. Samples: Submit, in air-tight containers, 40 lb. Sample of each type of fill to testing laboratory.

- C. Materials Source: Submit name of imported materials supplier(s). Provide materials from same source throughout the Work. Change of source requires Engineers approval.
- D. Laboratory Results: Submit in accordance with Section 01 33 00.

1.04 SEQUENCING AND SCHEDULING

- A. Construct aggregate base only after all of the following have been completed:
 - 1. Subgrade has passed density tests by independent testing laboratory and successfully passed a rolling test performed by the Contractor and witnessed by the Engineer.
 - 2. Subgrade has been checked for conformance to line and grade tolerances.
- B. Aggregate base to be completed and approved by Engineer prior to placement of surfacing materials.

1.05 QUALITY ASSURANCE

- A. Contractor shall establish and maintain the required lines and grades, including crown and cross-slope, for each course during work.
- B. In-place finished thickness will not be acceptable if exceeding following allowable variation from thickness specified herein:
 - 1. Aggregate Base Course: Plus or minus one-half inch.

PART 2 - PRODUCTS

2.01 AGGREGATE BASE COURSE

- A. Aggregate Base Course shall be as indicated on the Construction Drawings and as specified in Section 31 05 16.

PART 3 - EXECUTION

3.01 AGGREGATE BASE COURSE

- A. Preparation:
 - 1. Verify subsoil has been inspected; gradients and elevations are correct.
 - 2. Prepare the earth subgrade.
 - 3. Verify subsoil is compacted to specified density and that subgrade test results have been submitted prior to placing aggregate course.
 - 4. Correct irregularities in subsoil gradient and elevation by scarifying, reshaping, and re-compacting.

5. Subgrade to be completed and approved by Engineer prior to installation of the aggregate base course.
 6. Verify subgrade is dry.
- B. Construction Requirements; conform to SDDOT Specifications:
1. Place aggregate in maximum 6-inch layers and compact to specified density. When placing over geotextile fabric, place in minimum 12 inch (304.8 mm) layers.
 2. Level and contour surfaces to elevations and gradients indicated.
 3. Compact by mechanical means as specified in Section 01 45 00.
 4. Install aggregate base in accordance with Detail Drawings.
 5. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.
 6. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
- C. Field Quality Control:
1. Section 01 45 00 - Quality Control.
 2. Compaction testing shall be performed in accordance with ASTM D698 and ASTM D2922.
 3. The Contractor shall retain and pay for the services of an independent testing laboratory to sample the aggregate base materials, determine the moisture/density relationships and gradation, and perform field moisture/density tests at locations determined by Engineer.
 4. If, during progress of Work, tests indicate that compacted materials do not meet specified requirements, remove defective Work, replace, and retest. Contractor shall bear all costs associated with repair and retesting of defective Work.

3.02 SCHEDULES

- A. Base Course under Trench: As specified in Section 31 23 23.
- B. Base Course under Sidewalk: Minimum thickness of 6 inches (152.4 mm) of Type A3 aggregate base per Section 31 05 16. Level and compact base course to 98 percent of maximum ASTM D698 dry density.
- C. Base Course under Concrete or Bituminous Pavement: Minimum thickness of 12 inches (304.8 mm) of Type A3, aggregate base course material per Section SDDOT Standard Specifications for Roads and Bridges section 882.2 Table 1. Level and compact base course to 98 percent of maximum ASTM D698 dry density in 6-inch lifts. When geotextile is used, place first course in one 12-inch lift.

- D. Temporary Traffic Aggregate: Type A3 aggregate base per Section 31 05 16. Thickness as specified in bid documents or 4 inch (101.6 mm) minimum if not specified otherwise.

3.03 TOLERANCES

- A. Flatness: Maximum variation of $\frac{1}{4}$ inch measured with 10-foot straight edge.
- B. Scheduled Compacted Thickness: Within $\frac{1}{2}$ inch.
- C. Variation From Design Elevation: Within $\frac{1}{2}$ inch.

END OF SECTION 32 11 23

SECTION 32 13 13
CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Portland cement concrete pavement.
2. Curbs and gutters.
3. Reinforcement.
4. Joints and Joint Sealer.
5. Surface Finish.
6. Curing.
7. Construction requirements.
8. Materials.

B. Related Sections include, but are not limited to:

1. Drawings and general provisions of Contract, including General and Supplementary Conditions, apply to work of this section.
2. Section 01 33 00 - Submittal Procedures .
3. Section 01 45 00 - Quality Control.
4. Section 03 20 00 - Concrete Reinforcing .
5. Section 03 30 00 - Cast-in-Place Concrete .
6. Section 31 05 16 - Aggregates for Exterior Improvements.
7. Section 31 22 00 - Site Grading.
8. Section 33 40 00 - Storm Drainage Utilities

1.02 REFERENCE STANDARDS

A. References include, but are not limited to:

1. North Dakota Department of Transportation (NDDOT) Standard Specifications for Road and Bridge Construction, latest edition.
2. American Association of State Highway Transportation Officials (AASHTO).
3. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010 (Reapproved 2015).
4. ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete; 1991 (Reapproved 2009).
5. ACI 304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
6. ACI 305 - Guide to Hot Weather Concreting; 2010.
7. ACI 306 - Guide to Cold Weather Concreting; 2016.

8. ACI 308 - Guide to External Curing of Concrete; 2016.
9. ACI 330 - Guide for the Design of and Construction of Concrete Parking Lots; 2008.
10. ACI 347 - Guide to Formwork for Concrete; 2014 (Reapproved 2021).
11. ACI 421 - Design of Reinforced Concrete Slabs; 2016.
12. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2023.
13. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2023.
14. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2024.
15. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2021.
16. ASTM C150/C150M - Standard Specification for Portland Cement; 2022.
17. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2023.
18. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
19. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete; 2019.
20. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2024.
21. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2023, with Editorial Revision.
22. ASTM C595/C595M - Standard Specification for Blended Hydraulic Cements; 2021.
23. ASTM C685/C685M - Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing; 2017.
24. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2015.
25. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh to Hardened Concrete; 2021.
26. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete; 2022.

1.03 SUBMITTALS FOR REVIEW

- A. See Section 01 33 00 - Submittal Procedures, for submittals procedures.
- B. Product Data: Furnish data on aggregates, Portland cement, air-entraining agent, admixtures and other materials and on plant mix design in accordance with Sections 01 33 00 - Submittal Procedures and 01 45 00 - Quality Control at least 14 days prior to beginning paving operations. The Engineer must approve mix formula prior to its use on Project.

1.04 QUALITY ASSURANCE AND QUALITY CONTROL

- A. Obtain all materials from same source throughout Project.
- B. Source Quality Control Testing: Retain the services of an independent soil testing laboratory for Source Quality Control sampling and testing.
 - 1. Allow access by testing laboratory and/or agency to material stockpiles and facilities at all times.
- C. Contractor to obtain and pay for testing services from an independent geotechnical laboratory to monitor materials installed. The cost of testing is incidental to the contract. Contractor is responsible for scheduling and complying with geotechnical requirements.
 - 1. Allow access by testing laboratory and/or agency to material stockpiles and facilities at all times.
- D. Results of materials field testing shall be reported to the Owner and/or Engineer and Contractor.
- E. Material field tests may be witnessed by representatives of the Owner, Owner and/or Engineer, and Owner and/or Engineer's subconsultant and such witnessing shall be paid for by the Contractor .
- F. The following inspections and testing shall be conducted by the independent testing laboratory with results being reported to the Contractor and Owner and/or Engineer.
 - 1. Concrete Specimens:
 - a. Provide free access to concrete operations at project site and cooperate with appointed firm.
 - b. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
 - c. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure three concrete test cylinders. Obtain at least one test samples for every day of placement and for each 50 cubic yards or less of each class of concrete placed. Perform the following tests on each sample:
 - 1) Standard tests for slump, air content, and temperature are to be performed on fresh concrete each time cylinders are cast.
 - 2) Unit weight of plastic concrete.
 - d. Cast three (3) cylinders per set – one (1) at 7 days, one (1) at 14 days, and one (1) for 28 days.

- e. Cast one set of cylinders for five (5) cubic yards or larger per unit or structure. Cast an additional set of cylinders for each additional 150 cubic yards of cast-in-place concrete or masonry grout.
 - f. Cylinders (2 per set) shall be field cured.
 - g. Standard tests for slump, air content, and temperature are to be performed on fresh concrete each time cylinders are cast.
 - h. Concrete temperature shall be tested hourly, and recorded, when air temperature is 40 degrees Fahrenheit (4.44 degrees Celsius) and below, and when 80 degrees Fahrenheit (26.67 degrees Celsius) and above.
 - i. See Drawings or Code Required Special Inspections for additional requirements.
- G. Materials and installed work may require testing and retesting, as required by the Owner and/or Engineer, at any time during progress of work.
- 1. If tests indicate Work does not meet specified requirements, remove Work, replace, compact, and retest at no additional cost to Owner.
 - 2. The Contractor shall pay for those additional tests that fail to meet specified requirements, and the Owner will pay for those additional tests that do meet the specified requirements.
 - 3. The Owner and/or Engineer or their representative shall be present for all field sampling and lab testing performed for the Contractor.
 - 4. Failure to notify the Owner or Owner and/or Engineer of pending sampling or testing could result in rejection of submitted data and re-testing by in-place methods.
 - 5. The Owner reserves the right to order additional tests.
 - 6. All required data shall be received by the Owner and/or Engineer before payment for respective bid item(s) exceeds 75% of the total quantity.

1.05 REGULATORY AND ENVIRONMENTAL REQUIREMENTS

- A. Conform to applicable standards for paving Work on public and private property.
- B. Perform concrete paving Work in accordance with ACI 301.
- C. Conform to Section 01 55 00 - Vehicular Access and Parking Areas. Minimize interference with traffic.
- D. Perform concrete paving Work during extreme temperature conditions in accordance with ACI 305R for Hot Weather Concreting and ACI 306R for Cold Weather Concreting.
- E. Perform Work when ambient air temperature is rising and above 35 degrees F (measured in the shade and away from artificial heat). Discontinue Work when ambient air temperature is falling and reaches 40 degrees F (measured in the shade and away from artificial heat). Submit details of Contractor's means of cold

weather, frost protection for newly deposited concrete to Owner and/or Engineer for approval.

- F. No calcium chloride accelerations; non-chloride only.
- G. Do not place concrete when base or foundation is wet or frozen or when atmospheric conditions exist that would cause abnormal shrinking and checking of the pavement.

PART 2 - PRODUCTS

2.01 FORM MATERIALS

- A. Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when placed, impacted, and by vibration of any equipment, which they support, without spring or settlement.
- B. Except for metal forms, use new material, as needed. Previously used forms may be reused during the progress of the work, provided they are completely cleaned, reconditioned, recoated for each use, and capable of producing formwork of the required quality.
- C. For exposed concrete surfaces, provide forms that will give an aesthetically pleasing look when completed.

2.02 REINFORCEMENT

- A. Provide and install reinforcement that conforms to Section 03 20 00 - Concrete Reinforcing.

2.03 CONCRETE MATERIALS

- A. Portland Cement: Conform to ASTM C150/C150M, Type I, II, or III Portland cement, gray color.
- B. Fine and Coarse Mix Aggregates: Conform to ASTM C33/C33M.
 - 1. Shale and other deleterious and friable materials shall not exceed Class 3S weathering region per ASTM C33/C33M.
- C. Water: Potable, not detrimental to concrete.
- D. Air Entrainment: ASTM C260/C260M.
- E. Chemical Admixture: Conforming to ASTM C494/C494M: non-chloride accelerating admixtures shall be used.
- F. Other admixtures only with the written approval of Owner and/or Engineer.

2.04 ACCESSORIES

- A. Joint Sealers: Polyurethane elastomeric sealant for filling joints. Acceptable products Sikaflex 2C NS/NL or approved equivalent.
- B. Concrete Curing Materials: Shall conform to the following standards:
 - 1. Burlap cloth made from jute or kenaf: AASHTO M 182.
 - 2. Waterproof paper for curing concrete: AASHTO M 139.
 - 3. Liquid membrane forming compounds for curing concrete: AASHTO M 148.
 - 4. White polyethylene sheeting (film) for curing concrete: AASHTO M 171.
- C. Form Coating Materials: Shall be light commercial oil or other suitable substance that will prevent adherence of the concrete to the forms and will not reduce the strength of the concrete. In addition, the materials used for treating forms that will be in contact with concrete surfaces that are exposed to view in the finished work shall be a substance that will not appreciably affect the color of the concrete.

2.05 CONCRETE MIX - BY PERFORMANCE CRITERIA

- A. Mix concrete in accordance with ACI 304. Deliver concrete in accordance with ASTM C94/C94M.
- B. Provide concrete to the following criteria:
 - 1. Concrete Mix obtaining a minimum 28-day compressive strength of 4,000 psi and minimum 7-day and 28-day moduli of rupture (AASHTO T 97) of 550 and 600 psi, respectively.
 - 2. Maximum water/cement ratio of 0.42.
 - 3. Air content between 5 and 7 percent.
 - 4. Maximum slump of 3-inches, when tested without water-reducing admixture.
 - 5. Minimum cement content of 564 lbs./cubic yard.
 - 6. Type C Fly Ash meeting ASTM C618 may be used to replace cement on a 1:1 ratio, up to a maximum of 30 percent by weight.

2.06 EQUIPMENT

- A. Equipment and tools necessary for handling materials and performing all parts of the Work shall be sufficient as to design, capacity, and mechanical condition. The equipment shall be at the job site sufficiently before the start of construction operations.

2.07 SOURCE QUALITY CONTROL AND TESTS

- A. Section 01 45 00 - Quality Control: Provide concrete mix design and testing and analysis of aggregate material.

- B. Contractor shall submit samples, obtain aggregate gradation analyses, and submit for Owner and/or Engineer's approval. Minimum frequency for aggregate gradation analyses shall be one test per 1,000 tons of concrete mix produced or fraction thereof.
- C. Coarse Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136/C136M.
- D. Fine Aggregate Material - Testing and Analysis: Perform in accordance with ASTM C136/C136M.
- E. If tests indicate materials do not meet specified requirements, change material or material source and retest.
- F. Provide materials of each type from the same source throughout the Work.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify existing conditions and that compacted aggregate base is dry, stable, proper temperature, and compacted to specified density per Section 32 11 23 - Aggregate Base Courses . Verify aggregate base elevations are correct and at proper grade to receive concrete paving. Aggregate base shall be prepared as shown on the Drawings and per Section 32 11 23 - Aggregate Base Courses.
- B. Submit subgrade test results prior to placing concrete pavement.
- C. Verify Work of others affected has been completed and will not be adversely affected by paving operations. Verify that elevations of manhole and valve box castings in street or sidewalk are correct. Verify that curb depressions for sidewalks and driveways have been accommodated. Verify that drainage pattern matches storm water intake locations. Adjust utility appurtenances and castings per Sections 33 10 00 - Water Utilities and 33 40 00 - Storm Drainage Utilities.

3.02 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Adjust valve boxes, curb stops, manhole castings, and other utility structures to grade; coat manhole, catch basin, or other frames with oil to prevent bond with concrete pavement.
- C. Notify Owner and/or Engineer minimum 24 hours prior to commencement of concrete delivery and placement.

3.03 FORM MATERIALS

- A. Comply with ACI 301.

- B. Curb and gutter shape shall conform to the dimensions shown on the Drawings, Typical Sections, and/or Details.
- C. Concrete curb shall be recessed for handicap ramps where sidewalks cross the street.
- D. Use approved flexible forms on all curves where the radius is less than 20 times the length of the form.
- E. In the event of rain, forms shall be removed and reset as may be necessary to comply with above requirements.
- F. Clean forms prior to placement. Place and secure forms to correct size, location, dimension, profile, and gradient for sidewalk, driveway, and roadway paving thickness shown on the Drawings, Typical Sections, and Details for curbs and gutters.
- G. Forms shall have a height equal to the edge thickness of the sidewalk or pavement slab. Assemble formwork to fully support loading exerted by concrete placement and finishing operations without deflection, displacement, or settlement and to permit easy stripping and dismantling without damaging concrete. Forms shall be well oiled on the contact faces. Use light commercial oil or other suitable substance that will prevent adherence of the concrete to the forms and will not reduce the strength of the concrete.
- H. Provide formwork sufficiently tight to prevent leakage of cement paste during concrete placement. Solidly butt joints and provide backup material at joints as required, to prevent leakage.
- I. Place no concrete until Owner and/or Engineer has approved subgrade and forms. Forms for paving shall be set to the proper alignment and grade for a distance equal to at least 3 hours paving time prior to Owner and/or Engineer's approval.
- J. Moisten forms and subgrade immediately before placing concrete.
- K. Do not disturb or remove forms until the concrete has hardened sufficiently to permit removal with complete safety or unless otherwise approved by Owner and/or Engineer. Remove forms only during daylight hours and in a manner that avoids damage to pavement and curbs.

3.04 REINFORCING

- A. Steel Reinforcement:
 - 1. Comply with ACI 301 and placement shown on the Drawings.
Reinforcement shall be clean and free of rust scale, shall be of the type, style, and dimensions shown on the Drawings.

2. Place reinforcement as shown on Drawings within a tolerance of plus or minus ½ inch.

3.05 PLACING CONCRETE

A. Preparation:

1. Place no concrete until subgrade preparation, forms, and reinforcement have been inspected and approved and until elevations of castings have been verified.
2. Before placing concrete, thoroughly clean forms, wash out with water, and make tight. Sweep and wash all adjacent sidewalks next to the pour, so as to eliminate contamination from remaining debris.
3. Concrete in streets, sidewalks, parking lot, etc. are to be of the thickness as indicated on the Drawings, Typical Sections, and/or Details.
4. Deposit concrete in a manner to form a continuous, full-width mass requiring a minimum of rehandling and/or redistribution and to a sufficient depth to provide excess for finishing operations.
5. Do not dump or discharge concrete on or against a joint, reinforcement, insert, embedded part, or other assembly in a manner causing displacement or damage of the assembly.
6. Before new concrete is deposited upon or against concrete that has taken its initial set or has hardened, remove all encrustations from forms and reinforcement.

B. Method of Placing.

1. Do not place concrete outside of regular working hours, unless Owner and/or Engineer has been notified properly and is present.
2. Do not permit concrete to drop freely more than 4 feet. The concrete shall be placed in forms by means of a chute or hand shoveling.
3. Deposit concrete so that the surface is kept level throughout, a minimum being permitted to flow from one position to another, and place as rapidly as practicable after mixing.
4. Do not use in this Work any concrete not placed within 30 minutes after leaving the mixer.
5. If concrete placement is suspended for 30 minutes or less, cover the unfinished forward face of placed concrete with wet burlap until placement operations resume. When operations resume, break down forward face of placed concrete and thoroughly merge with fresh concrete. Continue consolidations and finishing operations on placed concrete throughout suspension period.
6. Do not break or interrupt successive pours such that cold joints occur. If the suspension of concrete placement exceeds 30 minutes, a standard head joint shall be constructed; provided, however, that no header joint

will be permitted within a distance of 10 feet from any adjacent transverse joint.

C. Consolidating

1. Consolidate concrete by an approved mechanical vibrator using a uniform rate of forward progress as soon as possible after placement of concrete on subgrade. Vibrate only once thoroughly and uniformly consolidate concrete throughout its entire depth and width without damaging or displacing joint assemblies and reinforcing. Segregation of concrete or undesirable water gain in the upper pavement zone due to excessive vibration will not be permitted. Suspend vibration whenever the forward progress of the machine is interrupted. Hand-held vibratory equipment is not approved unless Contractor demonstrates that adequate manpower is dedicated to consolidation operations and Owner and/or Engineer approves Contractor's plan and manpower commitment in writing. The Engineer may require the use of hand-held vibrators along the edge of existing pavement and curb. Suspend concrete paving if vibratory equipment failure occurs.
2. Thoroughly work concrete around reinforcements, and embedded fixtures, and into corners of forms during placing operations.

3.06 JOINTS

- A. Intervals, type, and dimensions shown on Drawings; firmly support rebar off subgrade with chairs. Where jointing plan is not shown, prepare and furnish jointing plan for review and approval of Owner and/or Engineer.
- B. Construct joints straight and at right angles to pavement surface. Where practical, all joints shall align with like joints in adjoining work. Use joints to outline all panels in sidewalks, making panels square insofar as possible. Maximum joint spacing in feet shall be 1.5 times pavement thickness in inches. Maximum length of panel shall be 1.5 times width.
- C. When placing concrete adjacent to existing working joints, use jointing techniques that will prevent random cracking of new pavement surfaces. Techniques may include soft sawing, placing pre-molded strips, or other approved methods.
- D. After the curing period, joints to be dried and sand cleaned prior to installation of joint material; seal with hot pour or silicone material meeting requirements of the NDDOT "Standard Specifications for Road and Bridge Construction;" slightly underfill joints by approximately 1/8 inch and remove excess seal material immediately.
- E. Transverse joints: at right angles to pavement and north/south Parking Lot centerline:

1. Match existing transverse joints.
 2. Saw cut 3/16 inch contraction joints to a depth of ¼ slab depth at optimum time after finishing to prevent formation of uncontrolled cracks due to contraction of slab;
 3. Provide construction joints as shown on Drawings and when concrete placement is suspended more than 30 minutes; no transverse construction joints shall be allowed between normal contraction joint locations; lay out joint locations to ensure that construction joints do not occur at prohibited locations.
- F. Longitudinal joints: parallel to pavement centerline and north/south Parking Lot centerline.
1. Match existing longitudinal joints.
 2. Placed as shown on Drawings; saw cut 3/16 inch contraction joints to a depth of ¼ slab depth at optimum time after finishing to prevent formation of uncontrolled cracks due to contraction of slab.
 3. Construct longitudinal construction joints, if required, as shown on Drawings. The key shall be constructed by placing a deformed metal plate against the form when the first lane adjacent to the joint is placed. Remove this metal plate with the form. When placing the second slab, no concrete shall be left to overhang the lip formed on the first slab by the edging tool. Before placing the second slab, the entire edge of the first slab shall be sprayed with concrete form oil to completely break the bond between adjacent slabs.
- G. Isolation joints: use to separate thickened edge sidewalk from parking lot and adjacent curb and gutter. Joint shall be full depth of pavement and dimensions shown in Drawings; when extending full width of 5-foot wide or wider pavement, increase depth 2-inches.
1. Sidewalk isolation joints; 5/8-inch wide and full slab thickness; premolded or poured material.

3.07 FINISHING

- A. When irregularities are discovered, they shall be corrected by adding or removing concrete. The pavement surface shall have no depression in which water will stand.
- B. Ensure that paving grade has a minimum slope of 0.4 percent.
- C. Street Pavement: Finish and texture street pavement transverse to pavement centerline so that finished elevations match existing street surfaces.
- D. Brooms shall be clean and free of dry or hardened mortar.

E. Finishing Schedules:

1. Driveways and Parking Lot: Surface shall be left slightly rough, with a uniformly tined finish. Streets shall be true to line and grade for existing concrete pavement street sections.
2. Driveways and aprons: Light broom texture parallel to centerline of street and curb and gutter, true to line and grade. The surface shall be slightly rough but uniform.
3. Sidewalks: Floated smooth and immediately after the water sheen disappears, broom lightly perpendicular to centerline followed by troweling joint edges. Use a clean broom at least 24 inches long and having three rows of bass, bassine, or coire fibers. Broom fibers shall be free of dry or hardened mortar from previous use. After final floating, apply the following finish:
 - a. Medium-to-Fine Textured Broom Finish: Finish for non-decorative concrete. Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
 - b. Medium-to-Coarse Textured Broom Finish: Finish for non-colored and colored scored concrete. Provide a coarse finish by striating float-finish concrete surface 1/16" to 1/8" deep with a stiff-bristled broom, perpendicular to line of traffic.
4. Curb and gutters: light broom.

F. Finishing Tolerances:

1. The true plane of the surface shall not vary more than 1/4 of an inch in 10 feet, as determined by a 10 foot straightedge placed anywhere on the slab in any direction.
2. Produce an initial surface which is relatively free from defects, but which still may show some trowel marks.
3. Provide a finished surface essentially free from trowel marks, uniform in texture and appearance, and in a plane of tolerance specified.

3.08 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature curing, sun, wind, excessively hot or cold temperatures, travel, and mechanical injury. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- B. When removal of formwork occurs before concrete has totally cured, concrete shall be protected from premature drying by covering with polyethylene sheeting.
- C. Cure all horizontal surfaces with wet cure or polyethylene film.

- D. Cure concrete by covering all exposed surfaces immediately after finishing for at least 30 hours with curing paper or plastic curing blanket or by application of a liquid-membrane curing-compound.
- E. When liquid membrane curing compound is used, apply at a rate of at least one gallon per 150 square feet in two equal applications 30 minutes apart. Protect joints to be sealed from entry of curing compound.
- F. The Contractor shall insure that the concrete has developed the necessary strength before forms are removed. Apply curing compound to exposed concrete after removal of forms.
- G. Promptly repair damaged curing compounds, paper, or blankets during the 30-hour curing period.
- H. Prevent the temperature of deposited concrete from falling below 50 degrees F. until at least 30 hours of curing has taken place. The Engineer may, at his/her discretion, extend this curing time for cold weather operations.
- I. Power equipment shall not operate on a pavement slab until it has attained a modulus of rupture flexural strength of 550 psi. The Engineer's written approval shall be required prior to equipment access onto pavement. In the event of damage to concrete resulting from the equipment or operations, suspend operation and correct damage. Contractor shall be responsible for any damage to pavement caused by his equipment or operations, regardless of Owner and/or Engineer's approval.
- J. New pavement shall not be opened for traffic until the joints have been sealed. New pavement may be opened to use by the general public vehicles when the concrete has attained a modulus of rupture flexural strength of 550 psi, provided pavement is in condition for safe use. Vehicular access limitations at colder temperatures will be extended at Owner and/or Engineer's discretion; consult Owner and/or Engineer before allowing vehicle access.
- K. Clean up paving area.

3.09 DEFECTIVE CONCRETE

- A. The following concrete will be deemed to be defective, poor in quality standards, and shall be removed and replaced promptly from the job site at no additional expense to the Owner.
 - 1. All concrete which is not formed as indicated, is not true to intended alignment, is not plumb or level where as intended, is not true to intended grades and levels;
 - 2. Has voids, honeycombs, or spalling that have been cut, resurfaced, or filled, unless with the approval of Owner and/or Engineer;

3. Has uncontrolled cracks greater than 1/32 inch in width;
4. Has sawdust, shaving, wood, dirt, rocks, or other embedded debris;
5. The flow line surface of gutters not finished and shaped as necessary to eliminate low spots and entrapment of water;
6. The top surface of the curbs, gutters, and curb radius shall be free from humps, sags, and other irregularities, shall be constructed to the elevations and widths shown in the Drawings and shall have edge alignment as straight as practicable on tangent sections and of uniform curvature on curved sections;
7. Or does not conform fully to provisions of the contract documents.

B. Repairs and Replacements:

1. Where defective concrete is found after removal of the forms, cut it out, if necessary, and make the surfaces match adjacent surfaces.

3.10 FIELD QUALITY CONTROL

A. Section 01 45 00 - Quality Control: Field inspection and laboratory testing.

1. Perform field and laboratory testing by an independent testing laboratory appointed and paid for by the Contractor.

B. Perform one (1) field slump, one (1) air entrainment, two (2) 7-day and two (2) 28-day cylinder compression tests, and two (2) each 7-day and 28-day beam modulus of rupture tests for standard concrete in accordance with ACI 301 on the following schedule.

1. Minimum testing frequency shall be the greater number of tests determined by the following criteria:
 - a. Once per day of paving operation
 - b. Once per city block of paving or fraction thereof
 - c. Once per 75 cubic yards or fraction thereof.
2. When ambient temperatures are below 45 degrees, one additional test cylinder shall be molded, cured on site under the same conditions as concrete it represents, and subsequently tested for 28-day compressive strength.
3. Notify testing laboratory to perform tests when testing is to be performed during construction.

C. Do not proceed with additional work until 7-day modulus of rupture results have been verified.

D. Provide computer generated batch tickets showing the weight of each component in the concrete mixture and the batching time with each batch of concrete delivered to the project. Contractor shall collect the batch ticket from

each load delivered and shall deliver the batch tickets to Owner and/or Engineer at the end of each day.

- E. Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature (3 times daily), and test samples taken.
- F. If, during progress of Work, tests indicate that concrete paving materials do not meet specified requirements, remove defective Work, replace and retest. Contractor to pay all costs associated with defective pavement work.

3.11 WORKMANSHIP AND TOLERANCES

- A. Flatness: Maximum variation of measured with a 10-foot straight edge shall be $\frac{1}{4}$ inch for pavement slabs and $\frac{1}{8}$ inch for sidewalks.
- B. Scheduled thickness: Within $\frac{1}{4}$ inch of specified thickness.
- C. Variation from true elevation: Within $\frac{1}{4}$ inch.
- D. Transverse slope of surface course shall not vary from the slope shown on Drawings by more than plus or minus $\frac{1}{4}$ inch in 12 feet.

3.12 SCHEDULE

- A. Sidewalks and Pedestrian Ways: As shown in typical sections, drawings, and/or details.
- B. Valley Gutters: As shown in drawings and/or details.
- C. Driveways: As shown in drawings and/or details.
- D. Curb and Gutter: As shown in typical sections, drawings, and/or details.
- E. Patches and Repairs: Match existing concrete thickness.

END OF SECTION 32 13 13

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SECTION 32 16 13
CURBS, GUTTERS, AND SIDEWALKS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Concrete Curb and Gutter.
2. Concrete Walks.
3. Truncated Domes.

B. Related Sections include:

1. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
2. Division 01 - General Requirements.
3. Division 31 - Earthwork.
4. Division 32 - Exterior Improvements.

1.02 REFERENCES

A. 2010 ADA Standards for Accessible Design.

B. Minnesota Department of Transportation (MnDOT) Standard Specifications for Construction, 2020 Edition.

1. Any measurement and payment provisions of reference standards do not apply to this project unless explicitly stated so within these specifications.

1.03 SUBMITTALS

A. Product Data: Furnish data on aggregates, Portland cement, air-entraining agent, admixtures, any other materials, and plant mix design in accordance with Sections 01 33 00 and 01 45 00 at least 7 days prior to beginning paving operations. Engineer must approve mix formula prior to its use on Project.

B. Samples for Verifications: For each type of exposed color, pattern, or texture indicated.

1.04 DELIVERY, STORAGE, AND HANDLING

A. None.

1.05 ADMINISTRATIVE REQUIREMENTS

A. None.

1.06 PRICE AND PAYMENT PROCEDURES

A. None.

1.07 QUALITY ASSURANCE REQUIREMENTS

A. None.

1.08 WARRANTY INFORMATION

A. None.

PART 2 - PRODUCTS

2.01 CONCRETE FOR WALKS

A. Materials for concrete walks shall meet the requirements of MnDOT 2521.2 including all referenced sections therein.

2.02 CONCRETE CURB AND GUTTER

A. Materials for concrete curb and gutter shall meet the requirements of MnDOT 2531.2 including all referenced sections therein.

PART 3 - EXECUTION

3.01 CONCRETE CURB AND GUTTER

A. This work shall consist of constructing Concrete Curb and Gutter in accordance with the provisions of MnDOT 2531, other Contract provisions, the Plan, and the following:

B. Construction Requirements

1. Concrete Curb and Gutter

a. The curb and gutter shall be constructed to meet the details in the Plan. The transition from the existing curb and gutter section to the new curb and gutter section should occur between 5 feet - 10 feet of the zero height curb. Curb shall be poured at 3.0% inflow around the radius or at a minimum distance of 10 feet from any zero height curb section when machine placed. The gutter inslope shall be constructed as detailed in the Plans. The gutter inslope transitions shall occur outside of the zero height curb area. The proposed gutter width shall be modified as necessary so as not to protrude into the adjacent travel lane with approval from the Engineer.

2. At all locations where new curb and gutter meets existing curb and gutter, place saw cut to leave a minimum 3 feet of in place curb and gutter between an existing joint and the proposed saw cut. If the 3-foot minimum cannot be maintained, place the saw cut over the existing joint. If

construction joints are utilized within a quadrant radius, reinforcement bars shall be installed per Standard Plans 5-297.250 (Sheet 6 of 6).

3. The Contractor must form, at a minimum, the top 1.5 inches of the gutter face. The Contractor shall not use the existing roadway edge as a form for the top 1.5 inches of the gutter face unless approved by the Engineer.
4. If the gutter flow line in front of the proposed curb ramp exceeds 2.0% slope, the flow line should be adjusted to 2.0% or less if feasible while following the roadway criteria as per Standard Plans 5-297.250 (Sheet 6 of 6). The bituminous patch in front of the truncated domes should be 1.0% minimum to 5.0% maximum measured perpendicular to the flow line. In no case shall a newly constructed curb and gutter flow line exceed 8.0% unless the roadway profile exceeds 8.0%.
5. The Contractor shall not alter any existing drainage patterns unless called for in the plans or approved by the Engineer.
6. The Contractor shall construct a contraction joint through the curb and gutter section at the bottom of the curb height transitions where the curb height equals zero inches. If any curb and gutter joints fall within the PAR, they shall meet MnDOT 2521.3D.
7. When constructing directional curb where truncated domes are placed perpendicular to the path of travel, the concrete between the grade break/edge of truncated domes and the gutter toe shall be constructed integral.
8. Where called for, reverse slope or reject gutter shall shed water to the parking area sloped away from the curb face at no more than 2.0%.

3.02 CONCRETE WALKS

- A. This work shall consist of constructing Concrete Walks in accordance with the provisions of MnDOT 2521, other Contract provisions, the Plan, and the following:
- B. Construction Requirements
 1. The minimum continuous and unobstructed clear width of a pedestrian access route shall be 4.0 feet. All new or reconstructed sidewalk widths shall match or exceed in place sidewalk and in no case shall it be less than 5.0 feet in width except at locations where obstructions cannot be moved or at driveways where slopes exceed the maximum allowable grades. The cross slope of the sidewalk or trail shall not exceed 2.0% and shall be measured across the entire surface width of the sidewalk or trail. Curb ramps shall meet or exceed existing sidewalk and trail widths, and the curb openings. Any architectural elements that do not maintain a consistent flat smooth surface shall not be used within the PAR.

2. In areas where the sidewalk is to be constructed around fixed structures and the grade has been changed, the sidewalk shall be finished around these structures to the satisfaction of the Engineer at no additional cost.
3. When greater than 50 feet of continuous sidewalk runs are constructed, the contractor shall saw cut all joints.
4. To avoid corner breaks, all walk edges shall be formed and constructed perpendicular to the back of curb and gutter sections and concrete structures for a one-foot minimum distance.
5. All existing signs shall be salvaged and reinstalled as directed by the Engineer or as indicated in the Plan.
6. Grading
 - a. If not otherwise detailed in the Plan, all fill sections shall be graded flush with the top of walk for a minimum 18 inches from the edge of walk and then down at a maximum 1:3 slope to existing terrain. The Contractor shall blend in the toe of fill slope and adjacent areas so as not to adversely affect drainage.
7. Landings
 - a. An initial landing is the first required landing of a pedestrian ramp. All initial landings required at the top of a ramped sloped surface (>2.0% longitudinal slope), shall be formed and placed separately in an independent concrete pour. This does not include initial landings placed at roadway grade such as depressed corners, parallel ramps, rural flat landings, or flat cut-throughs. Secondary landings consist of all landings beyond the initial landing. These secondary landings do not require a separate landing pour.
 - b. The entire landing should be placed in a single concrete pour and shall be constructed as a single plane surface having no grade breaks. If a single concrete pour is not possible due to construction staging, follow requirements for dowel bar placement and tie adjacent landings together. Architectural elements such as brick pavers, concrete stamping, and multiple colored concrete placements shall be kept outside the curb ramps and curb ramp landings.
 - c. Wet casting or drill and grouting of reinforcement bars will be required in accordance with the details shown in Standard Plan 5-297.250 Sheet 6 of 6. If wet casting reinforcement the bars shall be installed through holes in the forms, with a form height at least equal to the walk thickness of the formed concrete shown in the plans. These bars shall be deformed and shall be installed with 2 inches minimum concrete cover.

3.03 TRUNCATED DOMES

- A. Refer to the 2010 ADA Standards for Accessible Design for detectable warnings on curb ramps (truncated domes).
- B. This work consists of furnishing and installing Truncated Dome Systems (detectable warning surfaces) at pedestrian curb ramps in compliance with the Public Rights-of-Way Accessibility Guidelines (PROWAG). Truncated domes

shall provide a visual contrast to the concrete ramp of either dark on light or light on dark. This work shall be performed in accordance with the applicable MnDOT Standard Specifications, other Contract provisions, details in the Plan, and the following:

C. Construction Requirements

1. The Contractor shall select a truncated dome product from the approved products list at <http://www.dot.state.mn.us/products/detectablewarningsurfaces/index.htm>. The truncated domes shall be placed in concrete and shall be pressed firmly into the concrete to the point that concrete fills the vent holes on the truncated dome plates. No cutting of truncated domes will be allowed unless approved by the Engineer. No more than one cut dome per pedestrian ramp is allowed and any cut sections used shall not be less than 2 SF of surface area. All cut edges shall be ground to a smooth surface leaving no sharp edges or burrs. If using coated colored truncated domes, they shall not be cut. Any swelling of the concrete that occurs around the truncated domes must be screeded off and the surrounding concrete shall be finished flush with the truncated dome plate edge. The finished installation of the truncated domes plates and the ramp surface plane shall have no surface deviations over 3/16 inches. To ensure that the truncated domes are well seated in concrete, the Contractor should provide a 3-inch minimum border around the edges of the truncated domes.
2. The Contractor will be allowed to interchange 9-foot 5-inch and 10-foot radial truncated domes when either is called for in the Plan. If the Contractor does make a substitution, the Contractor will be required to modify the curb line radius to match the truncated domes and meet the detectable edge requirements shown on MnDOT Standard Plan Sheet No. 5-297.250 (Sheet 4 of 6). The Contractor will be allowed to adjust plan locations of zero inch height curb up to 6 inches laterally to make field fit adjustments for radial truncated domes placement.

END OF SECTION 32 16 13

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SECTION 32 31 13
FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Temporary chain link fence framework, fabric, and accessories.
2. Excavation for post bases.

B. Related sections included, but are not limited to:

1. Section 01 45 00 - Quality Control.
2. Section 01 51 00 - Temporary Utilities.
3. Section 01 56 00 - Temporary Barriers and Enclosures.
4. Section 03 30 00 - Cast-in-Place Concrete.

1.02 REFERENCES

A. Reference Standards include:

1. ANSI/ASTM A123 – Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A90/A90M – Test Method for Weight of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
3. ANSI/ASTM F567 – Installation of Chain-Link Fence.
4. ASTM A116 – Zinc-Coated (Galvanized) Steel Woven Wire Fence Fabric.
5. ASTM A120 – Pipe, Steel, Black, and Hot-dipped Zinc Coated (Galvanized) Welded and seamless, for Ordinary Uses.
6. ASTM A121 – Zinc Coated (Galvanized) Steel Barbed Wire.
7. ASTM A153 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
8. ASTM A370 – Mechanical Testing of Steel Products.
9. ASTM A392 – Zinc-Coated Steel chain-Link Fence Fabric.
10. ASTM A428 – Weight of Coating on Aluminum-Coated Iron or Steel Articles.
11. ASTM A491 – Aluminum-Coated Steel Chain Link Fence Fabric.
12. ASTM A569 – Steel, Carbon (0.15 Maximum Percent), Hot-Rolled Sheet and Strip Commercial Quality.
13. ASTM A585 – Aluminum Coated Steel Barbed Wire.
14. ASTM C694 – Ready-mixed Concrete.
15. ASTM F552 – Terminology Relating to Chain Link Fencing.
16. ASTM F567 – Installation of Chain Link Fence.
17. ASTM F573 – Residential Zinc-Coated Steel Chain Link Fence Fabric.
18. ASTM F626 – Fence Fittings.

19. ASTM F900 – Industrial and Commercial Swing Gates.
20. ASTM F1043 – Specifications for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.
21. ASTM F1083 – Pipe, Steel, Hot-Dipped Zinc Coated (Galvanized) Welded for Fence Structures.
22. ASTM F1184 – Industrial and Commercial Horizontal Slide Gate.

1.03 SYSTEM DESCRIPTION

- A. The manufacturer shall supply a fence system of black polymer coated chain-link fences and gates, as indicated on the drawings.
- B. Fence Height: 6 feet (182.88 cm) or as indicated on the Drawings.
- C. Line Post Spacing: At intervals not exceeding 10 feet (304.8 cm).
- D. Gates: 6 feet (182.88 cm) high and width as indicated on the drawings.

1.04 SUBMITTALS

- A. Submit under the provisions of Section 01 33 00.
- B. Product Data: For each type of product.
 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Fence and gate posts, rails, and fittings.
 - b. Chain-link fabric, reinforcements, and attachments.
 - c. Accessories:
 - d. Gates and hardware.
- C. Shop Drawings: For each type of fence and gate assembly.
 1. Include plans, elevations, sections, details, and attachments to other work.
 2. Include accessories, hardware, gate operation, and operational clearances.

1.05 PROJECT RECORD DOCUMENTS

- A. Submit under the provisions of Section 01 77 00.
- B. Accurately record actual locations of fence perimeter post relative to project site.

1.06 QUALITY ASSURANCE

- A. Perform Work in accordance with ANSI/ASTM F567.
- B. Testing Agency Qualifications: For testing fence grounding; member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.07 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum of three years experience.

1.08 FIELD MEASUREMENTS

- A. Verify that field measurements are as indicated on shop drawings.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

- A. Design: Engage a qualified fence design and installation company to design chain-link fence and gate frameworks.
- B. Structural Performance: Chain-link fence and gate frameworks shall withstand the design wind loads and stresses for fence height(s) and under exposure conditions indicated according to ASCE/SEI 7.
 - a. Minimum Post Size: Determine according to ASTM F1043 for post spacing not to exceed 10 feet (304.8 cm) for Material Group IA, ASTM F1043, Schedule 40 steel pipe.
 - b. Minimum Post Size and Maximum Spacing: Determine according to CLFMI WLG 2445, based on mesh size and pattern specified.

2.02 CHAIN-LINK FENCE FABRIC

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
 1. Fabric Height: 6'-0".
 2. Steel Wire for Fabric: Wire diameter of 0.148 inch (3.76 mm).
 - a. Mesh Size: 2 inches (50.8 mm).
 3. Selvage: knuckled top and bottom.

2.03 FENCE FRAMEWORK

- A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:
 1. Fence Height: 72-inch to top of fabric.
 2. Light-Industrial-Strength Material: Group IC-L, round steel pipe.
 - a. Line Post: 2.375 inches (60.32 mm) in diameter.
 - b. End, Corner, and Pull Posts: 2.875 inches (73.02 mm).

3. Horizontal Framework Members: top and bottom rails according to ASTM F1043.
 - a. Top Rail: 1.66 inches (42.16 mm) in diameter Sch. 40 steel pipe, hot dip galvanized per ASTM A120.
4. Brace Rails: ASTM F1043.
5. Metallic Coating for Steel Framework:
 - a. Type A: Not less than minimum 2.0-oz./sq. ft. average zinc coating according to ASTM A123/A123M or 4.0-oz./sq. ft. zinc coating according to ASTM A653/A653M.

2.04 TENSION WIRE

1. Polymer-Coated Steel Wire: 0.177-inch diameter, according to ASTM F1664, Class 2a, over zinc coated steel wire:
2. Type II: Zinc coated (galvanized) by hot-dip process, with the following minimum coating weight:
 - a. Color: Match chain link fabric.
 - b. Matching chain-link fabric coating weight.

2.05 SWING GATES

- A. General: ASTM F 900 for gate posts and double swing gate types.
 1. Gate Leaf Width: As indicated on Drawings.
 2. Framework Member Sizes and Strength: Based on gate fabric height of more than 72 inches (1828.8 mm).
- B. Pipe and Tubing:
 1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
 2. Gate Posts: Round tubular steel.
 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Extended Gate Posts and Frame Members: Fabricate gate posts and frame end members to extend 12 inches (304.8 mm) above top of chain-link fabric at both ends of gate frame to attach barbed wire assemblies.
- E. Hardware:
 1. Hinges: 360-degree inward and outward swing.
 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

2.06 FITTINGS

- A. Provide fittings according to ASTM F 626.

- B. Post Caps: Provide for each post.
 - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
 - 1. Top Rail Sleeves: Pressed-steel or round-steel tubing not less than 6 inches (152.4 mm) long.
 - 2. Rail Clamps: Line and corner boulevard clamps for connecting bottom rails to posts.
- E. Tension and Brace Bands: Pressed steel.
- F. Tension Bars: Steel, length not less than 2 inches (50.8 mm) shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
 - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, according to the following:
 - a. Hot-Dip Galvanized Steel: 0.148-inch diameter wire; polymer coating thickness matching coating thickness of chain-link fence fabric.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet (15240 cm) or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 CHAIN-LINK FENCE INSTALLATION

- A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete and/or by mechanically driving into soil at indicated spacing into firm, undisturbed soil.
 - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
 - 2. Concrete Fill: Place concrete around posts as indicated on Drawings. Protect aboveground portion of posts from concrete splatter.
 - a. Exposed Concrete: Extend 2 inches (50.8 mm) above grade; shape and smooth to shed water.
 - b. Concealed Concrete: Place top of concrete 2 inches (50.8 mm) below grade to allow covering with surface material.
 - 3. Mechanically Driven Posts: Drive into soil to depth 4 feet (121.92 cm). Protect post top to prevent distortion.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 30 degrees or more. For runs exceeding 500 feet (15240 cm), space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at 10 feet (304.8 cm) o.c.
- F. Post Bracing and Intermediate Rails: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
 - 1. Locate horizontal braces at midheight of fabric 72 inches (1828.8 mm) or higher, on fences with top rail, and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- G. Tension Wire: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches (609.6 mm) o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
 - 1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches (152.4

mm) of bottom of fabric and tie to each post with not less than same diameter and type of wire.

- H. Top Rail: Install according to ASTM F567, maintaining plumb position and alignment of fence posts. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 2-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts, with tension bands spaced not more than 15 inches (381 mm) o.c.
- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric according to ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
 - 1. Maximum Spacing: Tie fabric to line posts at 12 inches (304.8 mm) o.c. and to braces at 24 inches (609.6 mm) o.c.

3.04 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

3.05 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

3.06 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain chain-link fences and gates.

END OF SECTION 32 31 13

SECTION 32 39 14
SIGNAGE AND BOLLARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installation of all traffic regulatory and informational signage to include those identified on the drawings.
- B. Furnishing and installation of all protective bollards shown on the drawings.

1.02 REFERENCES

- A. South Dakota Department of Transportation Standard Specification for Roads and Bridges, latest edition.

1.03 SUBMITTALS

- A. Submittals required:
 - 1. Shop drawings on all signs, illustrating types of signs, messages and mounting.
 - 2. Shop drawings of all bollards to include bollard layout and description.

1.04 REGULATORY REQUIREMENTS

- A. Conform to all applicable City, State, and Federal Standards for signing.

PART 2 - PRODUCTS

2.01 SIGN BASE MATERIAL

- A. Sign base material for sign panels shall be sheet aluminum conforming to the material requirements of SDDOT Section 982.

2.02 SIGN FACE MATERIAL

- A. Sign face material for sign panels shall be high intensity reflective sheeting conforming to the material requirements of SDDOT Section 982.
- B. The colors of the panels are indicated on the Sign Schedule and shall conform to requirements of the FHWA and conform to the Color Tolerance Charts provided by the FHWA.

2.03 STANDARD CONSTRUCTION AND REGULATORY SIGNS

- A. Standard regulatory signs shall meet the requirements of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD).

2.04 FABRICATION

- A. Fabricate signs to comply with sign details and approved shop drawings, and conforming to the requirements of SDDOT Section 982.
- B. Allow for thermal expansion and contraction associated with exterior installation.
- C. Signposts and Hardware: Steel galvanized square perforated telescoping tubular posts shall conform to SDDOT Section 982.

2.05 POSTS AND HARDWARE FOR SIGNS

- A. The Contractor shall fabricate and install steel sign posts for all signs per SDDOT Section 982. and the details in the Drawings. Materials shall include the sign post, anchor, sleeve plates, shims, bolts, washers and other miscellaneous hardware required to provide a complete installation.

2.06 BOLLARDS

- A. Bollards shall be furnished and installed in the locations and in conformance with the details shown in the Drawings. Concrete for foundations shall be 3,000 psi (20684.28 kPa) minimum. Bollards shall be constructed of structural steel and shall be filled with concrete. Bollards shall be painted with prime coat and two finish coats of color selected by Engineer. Plastic protective sleeve shall be furnished and installed when indicated on Construction Details.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install signs without waves, warps, buckles, or fastening stress.
- B. Install signs straight and level. Balance signs as required. Install posts plumb.
- C. Install signs and posts in accordance with details in the drawings.
- D. Install signs to cast-in-place concrete columns or walls with at least four 3/8" lag screws and 1/4" neoprene pad washers. Provide all hardware as required.
- E. Install bollards in a rigid and substantial manner following the details provided in the drawings.

END OF SECTION 32 39 14

SECTION 32 92 19
SEEDING

PART 1 - GENERAL

1.01 SUMMARY

A. SECTION INCLUDES

1. Preparation of subsoil
2. Topsoil material and placement of topsoil
3. Landscape grading
4. All materials and labor needed to furnish a finished turf area
5. Maintenance and clean-up of work
6. Warranty and replacement of unsatisfactory materials
7. Seeding

B. RELATED SECTIONS

1. Division 01 – General Requirements
2. Division 31 – Earthwork
3. Division 32 – Exterior Improvements

1.02 REFERENCE STANDARDS

A. References

1. TPI (SPEC)- Guideline Specifications to Turfgrass Sodding; Turfgrass Producers International
2. AASHTO: American Association of State Highway and Transportation Officials
3. AOAC: Association of Official Agricultural Chemists
4. ASTM: American Society of Testing Materials
5. USDA: United States Department of Agriculture
6. ASTM: American Society for Testing and Materials

1.03 DEFINITIONS

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

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 00 - Submittal Procedures.

B. Product data

1. Submit certification of grass species and location of sod sources prior to use or installation
2. Submit container label of each seed mix certifying that the product meets the specified requirements prior to use or installation
3. Material Test Reports for imported or manufactured topsoil
4. Product certifications of soil amendments and fertilizers, from manufacturer

C. Work Schedules – Submit work schedule prior to start of work

1. Anticipated dates for seeding and/or sodding installation
2. Anticipated maintenance schedule as required in Part 3
3. Anticipated watering schedule as required in Part 3

D. Contract Closeout Submittals

1. As-Built Plans: After the work is complete submit to the Owner “as-built” plans including a listing of all species installed, and quantities installed. Mark in red ink on the original planting plan any field changes or deviations from the original plans.
2. Submit Owner Manual: Submit before expiration of required initial maintenance period.
 - a. Recommended procedures for maintenance of turf during a calendar year including:
 - 1) 1) Cutting method and maximum turfgrass height
 - 2) 2) Irrigation requirements of turfgrass
 - 3) 3) Types, application frequency, and recommended coverage
 - 4) 4) of fertilizer

1.05 QUALITY ASSURANCE

- A. Protection of Property: Contractor is responsible for damage to areas adjacent to planting area resulting from planting operations and shall bear full cost to repair damage. Accomplishment of repairs shall be equal to original installation prior to damage. Immediately report damage to Engineer and Owner and repairs shall be approved by both.
- B. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
1. Contractor experience: contractor shall have successfully installed at least three projects similar to that of this project within the last two years.

2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 3. Utilize experienced personnel familiar with equipment, methods and procedures for the job.
 4. Pesticide Applicator (Herbicide): State licensed, commercial.
- C. Utilize mechanical equipment of proper size and in good working condition to prosecute the work to full completion in a satisfactory manner.
- D. Soil Analysis
1. For each unamended soil type, furnish soil analysis and a written report by the Soil-Testing Laboratory.
 2. The testing laboratory shall conduct a comprehensive soil analysis to determine suitability of soils for horticultural purposes.
 3. The analysis shall be made in accordance with methods established by AOAC. Perform soil analysis to determine type and quantity of soil amendments; test enough soil samples to obtain a comprehensive analysis; submit reports.
- E. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by the Soil-Testing Laboratory.
1. The testing laboratory shall conduct a comprehensive soil analysis to determine suitability of soils for horticultural purposes.
 2. The analysis shall be made in accordance with methods established by AOAC. Perform soil analysis to determine type and quantity of soil amendments; test enough soil samples to obtain a comprehensive analysis; submit reports.
 3. The analysis report shall include at a minimum, soil texture, soil pH, macro and micronutrient levels, organic content, salinity, estimated infiltration rate and recommendations regarding amendments to the soil.
 4. Commercial test from an independent testing laboratory including basic soil groups (moisture and saturation percentages, Nitrogen Phosphorus-Potassium (N-P-K) ratio, pH (ASTM D 4972), soil salinity), secondary nutrient groups (calcium, magnesium, sodium, Sodium Absorption Ratio (SAR)), micronutrients (zinc, manganese, iron, copper), toxic soil elements (boron, chloride, sulfate), cation exchange and base saturation percentages. and soil amendment and fertilizer recommendations with quantities for plant material being transplanted.
 5. Recommendations for amendments shall include initial amendments, maintenance fertilization and long-term practicality regarding pH adjustments with quantities for plant material being transplanted.
 6. Analysis shall include mention of any soil characteristics that may adversely affect the long- term growth of healthy plants.

7. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.
8. If area to be planted will be filled by on-site excavations, stockpiled soils or imported soils, an adequate number of samples shall be taken from this/these materials
9. All tests to be performed by a Soil Testing Laboratory arranged and paid for by the Contractor.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaged Products

1. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable.
2. Provide seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging and location of packaging.
3. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
4. Deliver packaged products in original containers showing product name, weight, analysis, instructions for use and name of manufacturer.
5. Protect products from deterioration during delivery and storage on site.

B. Protection of Soils

1. Prevent compaction of topsoil and planting soils by vehicles, mechanical equipment and storage of materials during all phases of work.

C. Protection of Materials

1. Protect stockpiled materials to keep free of contamination from construction debris and windborne seed. Protect against loss by wind and erosion.
2. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
3. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

PART 2 - PRODUCTS

2.01 SEED MIXTURE

A. Seed Mixture:

1. For berms and lawn areas around building: 35% creeping red fescue, 30% Kentucky Bluegrass, 20% perennial rye grass, and 15% Chewings fescue. Application rate: 6 lbs. per 1,000 SF.
2. Temporary cover crop of oats at a rate of 3 lbs. per 1,000 SF shall also be seeded with seed mixtures.

2.02 SOIL MATERIALS

- A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.
- B. Topsoil: Excavated from site and free of weeds.

2.03 ACCESSORIES

- A. Mulching Material: Hydroseed mulch consisting of Hemlock wood cellulose fiber, free of growth or germination inhibiting ingredients. Application rate: 60 lbs. per 1,000 SF
- B. Fertilizer: 20-20-20 analysis; recommended for grass, with fifty percent of the elements derived from organic sources; or of proportion necessary to eliminate any deficiencies of topsoil, as indicated by analysis.
- C. Water: Clean, fresh and free of substances or matter that could inhibit vigorous growth of grass.
- D. Erosion Fabric: Jute matting, open weave.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance
 1. Verify that prepared soil base is ready to receive the work of this Section.
 2. Verify that no foreign or harmful material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 3. Uniformly moisten excessively dry soil that is not workable and which is too dusty.
 4. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination and replace with new planting soil.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 FIELD CONDITIONS

- A. Planting Restrictions: Coordinate planting periods with initial maintenance periods to provide required maintenance from date of substantial completion.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.
- C. The season of planting for seed mixtures runs from spring to early summer and from fall until the ground freezes. Seeding must be completed by October 15.
- D. Soils:
 - 1. When conditions that are potentially detrimental to turf growth are encountered, such as rubble fill, clay fill, adverse drainage conditions, obstructions, soil contaminants, compacted soils due to construction activities or like, Contractor shall notify Architect before proceeding with work in that area.
 - 2. If compacted soils have developed during construction process in areas where planting will occur, Contractor shall first till and harrow soil to a minimum depth of 8 inches (203.2 mm) prior to installation of plantings.
 - 3. In areas where masonry batch plants have been temporarily established on-site, all soils within area of batch plant shall be removed to full depth of contamination and disposed offsite. Contractor shall replace removed soils with planting soils as specified in this section.

3.03 PREPARATION

- A. Prepare subgrade in accordance with Section 31 23 13.
- B. Place topsoil in accordance with Section 31 22 00.
- C. In areas which have been disturbed and need to be seeded, fine grade to smooth, even surface with loose, uniformly fine texture. Roll, rake and drag lawn areas, remove ridges and fill depressions as required to meet finish grades.
- D. In areas which have not been disturbed and need to be seeded, till the soil to a depth of 6 inches (152.4 mm) soil to a homogenous mixture of fine texture, free of lumps, clods, stones, roots and other extraneous matter.
- E. Limit fine grading to areas which can be planted immediately after grading

- F. Install edging at periphery of seeded areas, where the seeded edge meets landscape beds or other plantings in straight lines to consistent depth.
- G. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 - 2. Protect grade stakes set by others until directed to remove them.
- H. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.04 FERTILIZING PRIOR TO SEEDING

- A. Apply fertilizer in accordance with manufacturer's instructions.
- B. Apply after smooth raking of topsoil and prior to roller compaction.
- C. Do not apply fertilizer at same time or with same machine as will be used to apply seed.
- D. Mix thoroughly into upper 2 inches (50.8 mm) of topsoil.
- E. Lightly water to aid the dissipation of fertilizer.
- F. Fertilizer should be applied to freshly tilled soil and incorporated into the top 6 inches (152.4 mm) of friable topsoil.
- G. Apply fertilizer to all lawn areas to be seeded at the rate of 400 lb. per acre. Apply in two operations while distributing fertilizer in a perpendicular path to previous application.
- H. Fertilizer used for lawn development shall be 20-20-20 (20 Percent Nitrogen, 20 percent Phosphate, 20 percent Potash).
- I. Do not apply fertilizer to areas which will be seeded with native grass.
- J. Apply fertilizer no more than 48 hours before laying sod.

3.05 PROTECTION & CLEAN-UP

- A. Protect seeded turf areas with temporary fencing or barricades around area periphery to protect newly planted areas from traffic. The stakes shall be spaced and of sufficient strength as to maintain plumb alignment and not bend from tension of string. Install 8.5x11 inch sign at 60 feet (1828.8 cm) on center which states, "Fresh Turf, Do not Enter". Maintain fencing and barricades through the initial maintenance period and remove after turf is established.

- B. Protect lawn work and materials from damage due to landscape operations, operations by other contractors and trades and trespassers. Maintain protection during installation and maintenance periods. Treat, repair and replace damaged lawn work.
- C. Protect adjoining pavements, walks, structures from dirt and staining during completion of work. Removal of such dirt and staining is required.
- D. During and after landscaping, keep pavements clean and work area in orderly condition. Remove promptly soil and other extraneous material brought onto paved areas by work operations. Keep paved areas clean at all times.
- E. Leave site free of debris from this Section of Work.
- F. Restore ground areas disturbed as a result of seeding operations to their original condition or to desired new appearance.

3.06 SILT FENCE REMOVAL

- A. Approximately 30 days after germination and if conditions permit, Contractor shall remove the silt fence. He shall subsequently backfill and regrade the fence trench, accomplish fine grading, seeding and begin turf development.
- B. Remove non-biodegradable erosion-control measures after grass establishment period.

END OF SECTION 32 92 19

SECTION 32 97 00
RESTORATION OF DISTURBED AREAS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Restoration of all areas disturbed during construction.
2. Restoration of all items not specifically identified for restoration but damaged through construction.

B. Related Sections include:

1. The General Conditions, Supplementary Conditions, and General Requirements apply to work of this section.
2. Division 01 – General Requirements.
3. Division 31 – Earthwork.
4. Division 32 – Exterior Improvements.

1.02 REFERENCES

A. Reference Standards include:

1. SDDOT Standard Specifications for Roads and Bridges, latest edition.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Material Sections include:

1. Topsoil and Subsoil: Per Section 31 05 13.
2. Aggregate Materials: Per Section 32 11 23.
3. Seed: Per Section 32 92 19.

PART 3 - EXECUTION

3.01 EXECUTION

- A. Observe all surface features requiring protection, removal and replacement, and/or restoration prior to construction.
- B. The Contractor shall be responsible for the preservation of all public and private property and shall protect carefully from disturbance or damage all land monuments and property marks until the Engineer has witnessed or otherwise referenced their location and shall not move them until directed.

- C. The Contractor shall be responsible for all damage or injury to property of any character during the prosecution of the Work, resulting from any act, omission, neglect, or misconduct in their manner or method of executing the Work, or at any time due to defective Work or materials and said responsibility will not be released until the Project has been completed and accepted.
- D. When any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct in the execution of the Work, or in consequence of the non-execution thereof by the Contractor, Contractor shall restore, at their own expense, such property to the condition similar or equal to that existing before such damage or injury was done by repairing, rebuilding, or otherwise restoring as may be directed or Contractor shall make good such damage or injury in an acceptable manner.

3.02 RESTORATION

- A. Restore all areas disturbed by construction to a condition equal to or better than existed prior to construction.
- B. Replace, restore, repair, or otherwise make good any damage done to any tree, bush, or shrub that is not specifically designated for removal.
- C. Restore items such as culverts, road signs, power poles, sodding, fences, driveways, curb and gutter, mailboxes, and like, whether or not specifically identified on the Drawings, to a condition equal to or better than existed before construction.
- D. Replace or repair all concrete or asphalt roads or driveways, removed or damaged during construction with equal or better materials. Replace or repair to match existing conditions.
- E. Stabilize subgrade sufficiently to prevent mixing of granular material with subgrade prior to application of base material.
- F. Place topsoil per Section 31 05 13 and seed areas disturbed by construction in grassed areas per Section 32 92 19.
- G. All damage to streets, driveways, berms, etc. due to the Contractor's construction techniques and equipment shall be repaired at the Contractor's expense prior to final payment.
- H. Remove all excess dirt, concrete, and other debris from work area immediately upon completion of Work and deposit on-site in a disposal area designated by Owner. Contractor shall be required to clean site to the condition prior to the start of construction before final payment will be made.

- I. Restore pavement markings on surfaces that were removed or damaged to match existing markings with suitable material to meet the Standard Construction Specifications of the South Dakota Department of Transportation Standard Specifications for Road and Bridge Construction, latest edition.
- J. All restoration shall be completed prior to opening any section of Work.

END OF SECTION 32 97 00

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DIVISION 33 UTILITIES

SECTION 33 05 13
MANHOLES AND STRUCTURES

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; 2025.
- B. ASTM C270 - Standard Specification for Mortar for Unit Masonry; 2025b.
- C. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets; 2021.
- D. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures; 2019.
- E. ASTM C890 - Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures; 2021.

1.02 SUMMARY

- A. Section includes:
 - 1. Modular precast concrete manhole sections with tongue-and-groove joints, precast cover and base slabs, frame and cover.
- B. Related sections include, but are not limited to:
 - 1. Division 01 – General Requirements
 - 2. Division 31 – Earthwork
 - 3. Division 32 – Exterior Improvements
 - 4. Division 33 – Utilities

1.03 REFERENCES

- A. References include, but are not limited to:
 - 1. ASTM A48 - Standard Specification for Gray Iron Castings.
 - 2. ASTM A496 - Deformed Steel Wire for Concrete Reinforcement.
 - 3. ASTM A497 - Welded Deformed Steel Wire Fabric for Concrete Reinforcement.
 - 4. ASTM A615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
 - 5. ASTM C478 - Precast Reinforced Concrete Manhole Sections.

6. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
7. ASTM C890 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures.
8. ASTM C923 - Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.
9. Federal Specification SS-S-00210 - Pre-formed Plastic Sealing Compound.

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Shop Drawings: Indicate manhole types, locations, elevations, piping, and conduit sizes and elevations of penetrations.
- C. Product Data: Provide manhole covers, component construction, features, configuration, and dimensions.

1.05 QUALITY ASSURANCE – DESIGN CRITERIA:

- A. All precast structures and components shall be designed under the direct supervision of a Professional Engineer registered in the State of South Dakota and fully experienced in design of precast concrete structural units. All precast structures and units shall be submitted during the shop drawings review process and bear the Registered Professional Engineer's Stamp and signature.
- B. Concrete dead load at 150 lbs./cf minimum. Design precast concrete units in accordance with ACI 318, under direct supervision of Professional Engineer registered in the State of South Dakota and fully experienced in design of precast concrete structural units.
- C. Design precast units and members to withstand their own weight, design loads due to the pressure and suction of wind, erection, handling and transportation forces, buoyancy, sinking, and all live and dead loads in accordance with applicable codes.
- D. Design component connections to provide for foundation settlement, chamber, and deflection without creating adverse reactions to other building materials or components.
- E. Steps and ladders shall be designed in accordance with ASTM C478-83, including but not limited to:
 1. Minimum design live load shall be a single concentrated load of 300 lbs.

2. Steps in all sections shall be aligned in each section so as to form a continuous ladder with rungs equally spaced vertically in the assembled manhole at maximum design distance of 12 inch (304.8 mm).

F. Perform Work in accordance with Section 01 45 00.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Owner until required for installation. Materials shall be transported, delivered, stored, and handled in accordance with Manufacturer's instructions and the requirements of Section 01 61 00.
- B. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Company shall specialize in manufacturing products specified in this section with a minimum of three years of experience.

2.02 PRECAST CONCRETE UNITS

- A. Manholes Sections: Reinforced precast concrete as outlined in ASTM C478 and able to withstand water loading requirements; including knockouts for wall pipes as shown on Drawings.
- B. Circular Sections: Reinforced precast concrete as outlined in ASTM C76 Class IV, double cage steel reinforcement, including knockouts for wall pipes and tie bolts.
- C. Box Sections: Reinforced precast concrete as outlined in ASTM C858, C890, and C913, double cage steel reinforcement, including knockouts for wall pipes and tie bolts.
- D. Manholes shall be sized as shown on the Construction Drawings or if size is not noted, as appropriately for piping size, type, and locations in accordance with manufacturer's recommendations.

2.03 JOINTS

- A. Precast concrete unit riser section joints shall be tongue and groove with rubber "O" ring joint gaskets. Profile joint gaskets may be used if reviewed and approved by Engineer.

- B. Precast concrete unit joints shall be formed entirely of concrete employing a circular cross section gasket, Press Seal, or equal. When assembled, the joint shall be self-centering and make a uniform watertight joint conforming to the requirements of ASTM C443.
- C. Joints shall also be sealed with a bituminous mastic joint sealing compound, Kent Seal No. 2, by Hamilton Kent Manufacturing Co., or equal.
- D. Provide external joint seal on all manhole section joints. External joint seal shall be a 12-inch-wide heavy bitumastic coating, Infi-Shield Seal Wrap, by Sealing Systems Inc., or equal.

2.04 BOTTOM SLAB SECTIONS

- A. Bottom slab sections shall be precast concrete conforming to ASTM C478 and of thickness, diameter, and reinforcement as shown on the Construction Drawings and manhole schedule. Bottom slabs shall be suitable for depth and groundwater conditions encountered.
- B. Inverts shall be formed as an integral part of the precast bottom and constructed as shown on the Drawings and shall have a smooth commercial finish.
- C. Bases shall be monolithic and integral with the first vertical section and include joints extending past pipe openings.
- D. Where there are changes in the direction of the flow or entering branches into the unit, the centerline of the invert shall have a true curve of as large a radius as the size of the manhole will permit. A minimum fall of 0.10 foot (3.05 cm) shall be provided through all manholes.
- E. The inside bottom of each unit shall be shaped with concrete to form a free flow channel through invert troughs.
- F. Reinforcement: Reinforce with deformed billet-steel conforming to ASTM A615 or deformed welded wire fabric conforming to ASTM A496 and ASTM A497 for the anticipated loading conditions.

2.05 TOP SLAB SECTIONS

- A. Top slab sections shall be precast concrete conforming to ASTM C478 and of thickness, diameter, and reinforcement as shown on the Construction Drawings and manhole schedule.
- B. Top slabs shall be suitable for H20 wheel loading and concrete dead load at 150 lbs./cf minimum.
- C. Commercial finish formed surfaces and broom finish top surface.

- D. Provide tapered handling hooks as required.
- E. Access hatches and or vent pipes shall be cast integral with the slab where required as shown on the Drawings.
- F. Reinforcement: Reinforce with deformed billet-steel conforming to ASTM A615 or deformed welded wire fabric conforming to ASTM A496 and ASTM A497 for the anticipated loading conditions.

2.06 MANHOLE STEPS

- A. Where called for on the Construction Drawings, American Step Company, Inc. ML-10 steps, M. A. Industries, or approved equivalent.
- B. Where called for on the Drawings, provide plastic steps placed at 12" spacing. Steps shall comply with ASTM C-478 and OSHA.
- C. Whenever possible, steps shall not be placed directly above the manhole flow channel. Steps should be located above the largest bench area in the manhole base. Steps shall be equally spaced, 12-inches on center maximum, for the entire depth of the manhole.

2.07 MANHOLE FRAMES AND COVERS

- A. Frames and covers for manholes, catch basins, grates, curb boxes, etc., shall be gray iron casting of the heavy-duty pattern conforming to the requirements of ASTM A48.
 - 1. Manufacturer and Products
 - a. Standard Manhole: Neenah Model R-1733 casting or Approved Equivalent.
 - b. As indicated on the Drawings.
- B. Casting weight shall be a minimum of 95 percent of the theoretical weight for a unit cast to exact dimensions, using a unit weight of 442 pounds per cubic foot.
- C. All inlets, frames, and grates shall be machined to a uniform quality. Metal used in the manufacture of frames and grates shall conform to ASTM-A48 Class 35B Gray (cast) iron. All frames shall fit together in a satisfactory manner to prevent rocking and rattling.
- D. Cover and seat shall have machined bearing surfaces to prevent rocking and rattling and have a concealed pickhole.
- E. Tops of covers shall be flush with ring edge of frames.
- F. Dimensions, details, weights, and class shall be as indicated on the Drawings for the specified design designation. Castings shall be Class 30 or better, unless noted otherwise.

- G. Where manhole covers are above finished grade or where shown on the Drawings, manhole frames shall be bolted down through the anchor base flange to the cone section with minimum four stainless steel anchor bolts.

2.08 GRADE ADJUSTMENT RINGS

- A. Grade adjustments of manhole frame and cover assemblies shall be provided utilizing reinforced concrete grade rings, standard two-inches thick. Each new manhole shall have a total height of adjustment between four (4) and ten (10) inches, unless shown on the Construction Drawings or otherwise indicated by Engineer.
- B. Precast reinforced concrete grade adjustment rings shall conform to ASTM C378 and shall be free from cracks, voids, and other defects.
- C. The diameter or rectangular dimension of rings shall conform to the type of casting on the structure.
- D. Provide grout or mortar between the rings.

2.09 CHIMNEY SEAL

- A. Chimney seal shall be Infishield, Cretex™ External Manhole Chimney Seal, or approved flexible sealing product per manufacturer's specifications.

2.10 MORTAR

- A. Mortar shall conform to ASTM C270. The cement shall be Type S masonry cement.
- B. Water shall be added for proper consistency. The entrained air content of the mortar shall range between seven (7) to ten (10) percent.
- C. Mortar sand volume shall equal 2.25 to 3.00 times the total volume of cement and lime.

2.11 NON-SHRINK MASONRY CEMENT

- A. Pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi (16547.42 kPa) in 48 hours and 7,000 psi (48263.32 kPa) in 28 days.

2.12 BEDDING AND COVER MATERIALS

- A. Reinforced Concrete Manhole:
 - 1. Manhole Base: Type A3 as specified in Section 31 05 16 and as shown on the Drawings.

2. Pipe Bedding: As specified in Section 31 05 16 and Section 31 23 33. The pipe shall be bedded in compacted granular material placed up to a height equal to one-half the outside diameter of the pipe. The depth of the granular bedding below the pipe shall be a minimum of 4" for 27" diameter and smaller pipe, 6" for 66" diameter pipe and larger, and 5" for intermediate sizes, and as shown on the Drawings.
3. Backfill Material: Fill Type S1 or S2, as specified in Section 31 05 13 and compacted as specified in Section 01 45 00.

2.13 PIPE CONNECTIONS TO MANHOLES

A. Grouted Connections (knock-outs)

1. Non-shrink masonry cement.
2. For larger knock-out openings, Contractor shall use bricks on the interior to provide a stable, hard surface for the non-shrink masonry cement.

B. Boot Connections

1. Pipe to manhole connections on all pipes shall be flexible and watertight. Pipe shall be sealed in the manhole section pipe openings with a resilient connector meeting the requirements of ASTM C923. The connection may be of the following types:
 - a. Rubber sleeve with stainless steel banding type, Press Seal PSX, A-Lok G3, or equal. Install by mechanical means in openings cut into manhole wall per ASTM C923.
 - b. Cast in place rubber gasket with stainless steel banding type, Press Seal Cast A Seal, or equal. Resilient connector shall be cast integrally into the wall of the manhole section at time of manufacture.
 - c. Core drilled connections shall utilize link seal where indicated on the drawings.

C. Connection to existing Manholes (required Engineer approval)

1. Manhole adaptor water stop
 - a. Conform to ASTM D5926.
 - b. Elastomeric PVC.
 - c. Manufactured by Fernco or Approved Equivalent.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Verify items provided by other sections of Work are properly sized and located.
- B. Verify that built-in items are in proper location, and ready for roughing into Work.
- C. Verify excavation for manholes is correct.

- D. Verify existing storm sewer is no longer in use prior to abandonment of existing manholes.

3.02 PREPARATION

- A. Coordinate placement of inlet and outlet pipe or duct sleeves required by other sections.

3.03 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature to minimum 50° F prior to, during, and 48 hours after completion of masonry Work.

3.04 PLACING MANHOLE SECTIONS

- A. Place base pad, trowel top surface level.
- B. Place manhole sections plumb and level, trim to correct elevations, anchor to base-pad, and seal section joints as noted on the Construction Drawings.
- C. Provide openings for existing pipe connections and new pipe that conform to the required pipe connection types.
- D. Grouted pipe openings shall be sealed with non-shrink masonry cement.
- E. Boot-sealed pipe openings shall be sealed as noted on the Construction Drawings and specifications.
- F. Grout lifting holes neatly to the curvature of the barrel with non-shrink masonry cement. Trowel smooth. Contour as required.
- G. Install preformed plastic sealing compound or water stop as required between joints of manhole sections to insure leak proof manhole.
- H. Adjusting rings should be set in place and grouted with mortar or non-shrink masonry cement to provide a smooth appearance, and connections shall be watertight.
- I. Install chimney seal around adjusting rings, edge of casting frame, and upper barrel section (where applicable) and to manufacturer's specifications.
- J. Set cover frames and covers level without tipping, to correct elevations.
- K. Coordinate with other sections of work to provide correct size, shape, and location.
- L. Construct concrete bench and channel.
- M. Manhole and casting final rim surface elevations shall be one-half inch below pavement elevation when set in pavement, or at grade when set in turf.

3.05 MANHOLE STEPS

- A. Manholes shall be placed at a spacing as noted on the Construction Drawings. If no spacing is noted, steps on 12-inch centers shall be provided.
- B. Steps in all sections shall be aligned in each section so as to form a continuous ladder with rungs.
- C. Steps shall project a minimum of 4 inches (101.6 mm) from the manhole wall.
- D. Whenever possible, steps shall not be placed directly above the manhole flow channel. Steps should be located above the largest bench area in the manhole base.

3.06 TOLERANCES

- A. All manholes and structures shall have finished elevations within + / - 0.05 feet (1.52 cm) of the elevations shown on the Construction Drawings.

END OF SECTION 33 05 13

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SECTION 33 05 26
UTILITY IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. GPS Mapping
 - 2. Tracer Wire.
 - 3. Tracer Wire Access Box.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 33 00 - Submittal Procedures.
 - 2. Section 31 23 33 - Trenching and Backfilling.
 - 3. Section 33 10 00 - Water Utilities.
 - 4. Section 33 30 00 - Sanitary Sewer Utilities.
 - 5. Section 33 40 00 - Storm Drainage Utilities.
- C. This Section also includes the South Dakota Department of Transportation (SDDOT) 2015 Standard Specifications for Roads and Bridges, including Supplemental Specifications and Supplemental Specifications for Errata
- D. This section also includes the Minnesota Rural Water Association Sewer/Water Utility – Trace Wire Specification, 2014 Edition attached in the Appendix
 - 1. Found <https://www.mrwa.com/PDF/TracerWireSpecGuideFinalweb7.pdf>

1.02 SUBMITTALS

- A. Submit under provisions of Section 01 33 00.
- B. Shop Drawings: Submit manufacturer's data on materials furnished indicating compliance with the specifications.

PART 2 - PRODUCTS

2.01 WARNING TAPE

- A. Install warning tape on all buried pipes.
- B. Tape shall be labeled as follows:

Pipeline	Warning Notice	Color
Sanitary Sewer	Caution Buried Sewer Line Below	Green

Storm Sewer	Caution Buried Storm Drain Below	Green
Potable Water Main	Caution Water Line Buried Below	Blue
Electric	Caution Electric Line Buried Below	Red
Gas	Caution Gas Line Buried Below	Yellow

2.02 TRACER WIRE SYSTEMS:

- A. Tracer wire shall be direct bury wire and shall be installed on all water mains, sanitary sewer pipelines, stormwater pipes, and gas pipelines.
- B. APPROVED PRODUCTS
 1. Copper clad Steel (CCS) trace wire
 - a. Open Trench – Copperhead #12 High Strength part # 1230-HS
 - b. Directional Drilling/Boring - Copperhead Extra High Strength part # 1245*EHS
 - c. Pipe Bursting/Slip Lining – Copperhead SoloShot Extreme Strength 7 x 7 Stranded part # PBX-50
 - d. Approved Equivalent
 2. Connectors
 - a. Copperhead 3-way locking connector part # LSC1230*
 - b. DryConn 3- way Direct Bury Lug: Copperhead Part # 3WB-01
 - c. Approved Equivalent
 3. Termination/Access
 - a. Non-Roadway access boxes applications: Trace wire access boxes Grade level Copperhead adjustable lite duty Part # LD14*TP
 - b. Concrete / Driveway access box applications: Trace wire access boxes Grade level Copperhead Part # CD14*TP 14"
 - c. Fire hydrant trace wire access box applications: Above ground two terminal with 1" conduit. Copperhead part # T3-75-F (Cobra T3 Test Station, denoting "F" includes mounting flange)
 - d. Approved Equivalent
 4. Grounding
 - a. Drive in Magnesium Anode: Copperhead Part # ANO-1005 (1.5 lb)
 - b. Approved Equivalent

C. TRACE WIRE

1. Open Trench - Trace wire shall be #12 AWG Copper Clad Steel, High Strength with minimum 450 lb. break load, with minimum 30 ml HDPE insulation thickness.
2. Directional Drilling/Boring - Trace wire shall be #12 AWG Copper Clad Steel, Extra High Strength with minimum 1,150 lb. break load, with minimum 30 ml HDPE insulation thickness.

3. Trace wire – Pipe Bursting/Slip Lining - Trace wire shall be 7 x 7 Stranded Copper Clad Steel, Extreme Strength with 4,700 lb. break load, with minimum 50 ml HDPE insulation thickness.

D. CONNECTORS

1. All mainline trace wires must be interconnected in intersections, at mainline tees and mainline crosses. At tees, the three wires shall be joined using a single 3-way lockable connector. At Crosses, the four wires shall be joined using a 4-way connector. Use of two 3-way connectors with a short jumper wire between them is an acceptable alternative.
2. Direct bury wire connectors – shall include 3-way lockable connectors and mainline to lateral lug connectors specifically manufactured for use in underground trace wire installation. Connectors shall be dielectric silicon filled to seal out moisture and corrosion, and shall be installed in a manner so as to prevent any uninsulated wire exposure.
3. Non-locking friction fit, twist on or taped connectors are prohibited.

E. TERMINATION/ACCESS

1. All trace wire termination points must utilize an approved trace wire access box (above ground access box or grade level/in-ground access box as applicable), specifically manufactured for this purpose.
2. All grade level/in-ground access boxes shall be appropriately identified with “sewer” or “water” cast into the cap and be color coded.
3. A minimum of 2 feet (60.96 cm) of excess/slack wire is required in all trace wire access boxes after meeting final elevation.
4. All trace wire access boxes must include a manually interruptible conductive/connective link between the terminal(s) for the trace wire connection and the terminal for the grounding anode wire connection.
5. Grounding anode wire shall be connected to the identified (or bottom) terminal on all access boxes.
6. Service Laterals on public property - Trace wire must terminate at an approved grade level/in-ground trace wire access box, located at the edge of the road right-of-way, and out of the roadway.
7. Service Laterals on private property - Trace wire must terminate at an approved above-ground trace wire access box, affixed to the building exterior directly above where the utility enters the building, at an elevation not greater than 5 vertical feet above finished grade, or terminate at an approved grade level/in-ground trace wire access box, located within 2 linear feet of the building being served by the utility.
8. Hydrants – Trace wire must terminate at an approved above-ground trace wire access box, properly affixed to the hydrant grade flange. (affixing with tape or plastic ties shall not be acceptable)

9. Long-runs, in excess of 1,000 linear feet without service laterals or hydrants - Trace wire access must be provided utilizing an approved grade level/in-ground trace wire access box, located at the edge of the road right-of-way, and out of the roadway. The grade level/in-ground trace wire access box shall be delineated using a minimum 48" polyethylene marker post, color coded per APWA standard for the specific utility being marked.

F. GROUNDING

1. Trace wire must be properly grounded at all dead ends/stubs
2. Grounding of trace wire shall be achieved by use of a drive-in magnesium grounding anode rod with a minimum of 20ft of #14 red HDPE insulated copper clad steel wire connected to anode (minimum 0.5 lb.) specifically manufactured for this purpose, and buried at the same elevation as the utility.
3. When grounding the trace wire at dead ends/stubs, the grounding anode shall be installed in a direction 180 degrees opposite of the trace wire, at the maximum possible distance.
4. When grounding the trace wire in areas where the trace wire is continuous and neither the mainline trace wire or the grounding anode wire will be terminated at/above grade, install grounding anode directly beneath and in-line with the trace wire. Do not coil excess wire from grounding anode. In this installation method, the grounding anode wire shall be trimmed to an appropriate length before connecting to trace wire with a mainline to lateral lug connector.
5. Where the anode wire will be connected to a trace wire access box, a minimum of 2 feet (60.96 cm) of excess/slack wire is required after meeting final elevation.

PART 3 - EXECUTION

3.01 GPS MAPPING

- A. All piping and fittings shall be mapped using GPS after final locations have been determined and prior to backfilling. GPS shall provide horizontal and vertical control.
- B. GPS points shall be recorded at minimum at the following locations:
 1. Along all piping lengths at a distance not to exceed 100 feet (3048 cm) between points.
 2. All points where a pipe experiences a change in direction. If a pipe is installed in a bent fashion the number of GPS points taken shall be sufficient to accurately determine the location of the pipe through the bend.

3. All fittings such as elbow, tees, etc., shall be mapped.
 4. Pipe terminals – beginnings and endings.
- C. Saving of GPS data shall be confirmed prior to backfilling. GPS mapping data shall be submitted to the Engineer in an organized manner.

3.02 INSTALLATION

- A. Trace wire installation shall be performed in such a manner that allows proper access for connection of line tracing equipment, proper locating of wire without loss or deterioration of low frequency (512Hz) signal for distances in excess of 1,000 linear feet, and without distortion of signal caused by multiple wires being installed in close proximity to one another.
- B. Trace wire systems must be installed as a single continuous wire, except where using approved connectors. No looping or coiling of wire is allowed.
- C. Any damage occurring during installation of the trace wire must be immediately repaired by removing the damaged wire, and installing a new section of wire with approved connectors. Taping and/or spray coating shall not be allowed.
- D. Trace wire shall be installed at the bottom half of the pipe and secured (taped/tied) at 5' intervals.
- E. Trace wire must be properly grounded as specified.
- F. Trace wire on all service laterals/stubs must terminate at an approved trace wire access box located directly above the utility, at the edge of the road right-of-way, but out of the roadway. (See Trace wire Termination/Access)
- G. At all mainline dead-ends, trace wire shall go to ground using an approved connection to a drive-in magnesium grounding anode rod, buried at the same depth as the trace wire. (See Grounding)
- H. Mainline trace wire shall not be connected to existing conductive pipes. Treat as a mainline dead-end, ground using an approved waterproof connection to a grounding anode buried at the same depth as the trace wire.
- I. All service lateral trace wires shall be a single wire, connected to the mainline trace wire using a mainline to lateral lug connector, installed without cutting/splicing the mainline trace wire.
- J. In occurrences where an existing trace wire is encountered on an existing utility that is being extended or tied into, the new trace wire and existing trace wire shall be connected using approved splice connectors, and shall be properly grounded at the splice location as specified.

3.03 WATER SYSTEM

- A. A mainline trace wire must be installed, with all service lateral trace wires properly connected to the mainline trace wire, to ensure full tracing/locating capabilities from a single connection point.
- B. Lay mainline trace wire continuously, by-passing around the outside of valves and fittings on the North or East side.
- C. Trace wire on all water service laterals must terminate at an approved trace wire access box color coded blue and located directly above the service lateral at the edge of road right of way.
- D. Above-ground tracer wire access boxes will be installed on all fire hydrants.
- E. All conductive and non-conductive service lines shall include tracer wire.

3.04 PROHIBITED PRODUCTS AND METHODS

- A. The following products and methods shall not be allowed or acceptable:
 - 1. Uninsulated trace wire
 - 2. Trace wire insulations other than HDPE
 - 3. Trace wires not domestically manufactured
 - 4. Non locking, friction fit, twist on or taped connectors
 - 5. Brass or copper ground rods
 - 6. Wire connections utilizing taping or spray-on waterproofing
 - 7. Looped wire or continuous wire installations, that has multiple wires laid side-by-side or in close proximity to one another
 - 8. Trace wire wrapped around the corresponding utility
 - 9. Brass fittings with trace wire connection lugs
 - 10. Wire terminations within the roadway, i.e. in valve boxes, cleanouts, manholes, etc.
 - 11. Connecting trace wire to existing conductive utilities

3.05 TESTING

- A. All new trace wire installations shall be located using typical low frequency (512Hz) line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership.
- B. This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project.
- C. Continuity testing in lieu of actual line tracing shall not be accepted.

END OF SECTION 33 05 26

SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Piping Materials and Fittings
2. Polyethylene Encasement
3. Valves
4. Reaction Backing (Thrust Blocking)
5. Bedding and Backfilling
6. Fire Hydrants
7. Appurtenances
8. Pipe Installation
9. Pipe Thrust Restraint
10. Air and Vacuum Valve

B. Related Sections include, but are not limited to:

1. Section 01 31 13 - Project Coordination.
2. Section 01 31 19 - Project Meetings.
3. Section 01 33 00 - Submittal Procedures.
4. Section 01 45 00 - Quality Control.
5. Section 01 61 00 - Common Product Requirements.
6. Section 31 05 13 - Soils for Earthwork.
7. Section 31 05 16 - Aggregates for Exterior Improvements.
8. Section 31 23 33 - Trenching and Backfilling.
9. Section 33 13 00 - Disinfection of Water Systems.

1.02 REFERENCES

A. Reference Standards include, but are not limited to:

1. ASTM A536 – Ductile Iron Castings.
2. ASTM D3139 – Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals.
3. ANSI/AWWA C104/A21.4 - Cement-Mortar Lining for Gray-Iron and Ductile-Iron Pipe and Fittings for Water.
4. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for Water and Other Liquids.
5. ANSI/AWWA C110/A21.10 - Gray-Iron and Ductile-Iron Fittings, 3-Inch through 48-Inch, for Water and Other Liquids.

6. ANSI/AWWA C111/A21.11 - Rubber Gasket Joints for Gray-Iron and Ductile-Iron Pressure Pipe and Fittings.
7. ANSI/AWWA C150/A21.50 - American National Standard for Thickness Design of Ductile-Iron Pipe.
8. ANSI/AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids.
9. ANSI/AWWA C153/A21.53 - Ductile-Iron Compact Fittings, 3-Inch through 12-Inch, for Water and Other Liquids.
10. AWWA C509 - Resilient-Seated Gate Valves, 3 through 12 NPS, for Water and Sewage Systems.
11. AWWA C550 - Standard for Protective Epoxy Interior Coating for Valves and Hydrants.
12. AWWA C600 - Installation of Ductile Iron Water Mains and Their Appurtenances.
13. AWWA C605 - Underground Installation of PVC Pressure Pipe and Fittings.
14. AWWA C800 - Standard for Underground Service Line, Valves, and Fittings.
15. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 In., for Water.
16. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. through 48 In., for Water Transmission and Distribution.
17. AWWA C906 - Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 63 In., for water distribution.
18. ASTM D1784 - Rigid Poly (Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds.
19. ASTM D1785 - Poly (Vinyl Chloride) Plastic Pipe, Schedules 40, 80, and 120.
20. ASTM D2241 - Poly (Vinyl Chloride) (PVC) Plastic Pipe (SDR-PR).
21. ASTM D2466 - Poly (Vinyl Chloride) (PVC) Plastic Pipe fittings, Schedule 80.
22. ASTM F2306 – 12 to 60in. Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications.
23. ASTM F2648 – 2 to 60in. Annular Corrugated Profile Wall Polyethylene (PE) Pipe and Fittings for Land Drainage Applications.
24. ASTM F477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe
25. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
26. NSF Standard No. 14, 60, and 61 - National Sanitation Foundation.
27. WW-T-779c – Federal Specifications

1.03 SUBMITTALS

- A. A Product Data per Section 01 33 00 for all pipe and fittings indicating: Name of Manufacturer, Materials, Standard Dimensions, References, Joint Data, maximum loadings, and thrust restraints.
 - B. Line layout, laying schedule, and marking diagrams which indicate the specific number of each fitting and the location and the direction of each fitting in the completed line. In addition, the line layouts shall include: the pipe station and invert elevation at all changes in grade or horizontal alignment; all elements of curves and bends, both in horizontal and vertical alignment; and the limits of each reach of restrained joints.
 - C. Provide a list of materials and corresponding suppliers.
 - D. Submit Affidavit of Compliance certifying that materials furnished have been tested and are in compliance with specification requirements.
- 1.04 1. SUBMIT DESIGN CALCULATIONS FOR STRUCTURAL DESIGN OF PIPE THICKNESS WHERE PIPE CLASS OR THICKNESS IS NOT SPECIFICALLY CALLED OUT.
- A. Product Data: Provide data on pipe materials, pipe fittings, valves and accessories.
 - B. Manufacturer's Instructions: For valves, hydrants, and specialties, furnish in accordance with Sections 01 61 00 and 01 77 00 manufacturer's printed instruction for delivery, handling, storage, assembly, installation, adjustment, special tool requirements, and maintenance requirements.
 - C. In accordance with Section 01 77 00, provide records of measured depths of water mains, service leads, valves, connections, transition couplings, adapters, thrust blocking; measured horizontal and vertical locations of underground utilities and appurtenances referenced to permanent surface improvements; measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work; field changes of dimension and detail.
- 1.05 MANUFACTURER'S CERTIFICATES AND REPORTS
- A. Manufacturer Pipe Certifications:
 - 1. Signed by the pipe manufacturer certifying that the pipe complies with requirements specified in the specifications and is suitable for installation based on the proposed bedding and backfilling specifications.
- 1.06 QUALITY ASSURANCE
- A. Perform Work in accordance with Section 01 45 00.

- B. Valves and Hydrants: Manufacturer's name and pressure rating marked on valve and hydrant body.

1.07 FIELD MEASUREMENTS

- A. The Drawings indicate required pipe sizes and the general arrangement for major piping. Locations shall be verified in the field by the Contractor. Valves, fittings, and appurtenances shall be of such dimensions to allow for the installation of this piping substantially as shown on the Drawings. In the event it should become necessary to change the location of any of the work due to interference with other work, Contractor shall consult with the Engineer prior to making any changes and all such changes shall be made at no additional cost to the Owner.
- B. Prior to roughing in any facilities or installation of piping and equipment, consult all related drawings including general, mechanical, electrical, etc., and inform self of materials, locations of structures, pipes, duct banks, electrical conduits, etc., which may impact the installation.
- C. Discrepancies discovered before or after work has started, shall be brought to the attention of the Engineer immediately, and the Engineer reserves the right to require minor changes in the work to eliminate such discrepancies.
- D. Pipe connections to equipment shall be subject to approval of Engineer and coordinated to meet the manufacturer's recommendations and requirements.
- E. No work that connects directly to equipment shall be installed before complete shop drawings of said equipment have been reviewed and approved by the Engineer.

1.08 PROJECT CONDITIONS

- A. Verify all dimensions of and between existing structures and locations of existing piping and equipment required for the proper installation of all new piping and equipment.
- B. Contractor shall be responsible for verification of location of all existing piping and structures. Potholing and or excavation to expose existing piping, conduits, etc. may be required prior to installation of new piping or connection to existing piping. Adjustments to the locations of new piping may be required due to locations of existing piping and sequencing of construction that will be required. Adjustments required shall be at no additional cost to the Owner.

1.09 DELIVERY, STORAGE, AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Owner until required for installation. Materials shall be transported, delivered,

stored, and handled in accordance with Manufacturer's instructions and the requirements of Section 01 61 00.

- B. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.

1.10 REGULATORY REQUIREMENTS

- A. All products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each product.

PART 2 - PRODUCTS

2.01 DUCTILE IRON PIPE (DIP)

- A. Approved Manufacturers

1. American Cast Iron Pipe Company
2. McWane Ductile
3. U.S. Pipe
4. Approved Equivalent

- B. Pipe

1. Pipe shall be in accordance with AWWA/ANSI C111/A21.11, AWWA/ANSI C150/A21.15, and AWWA/ANSI C151/A21.51.
2. All Pipe shall meet requirements of NSF 61.
3. Pipe shall have a lay length of 18 feet (548.64 cm) or 20 feet (609.6 cm) except for special fittings or closure pieces and necessary to comply with the drawings.
4. As a minimum the following pressure classes apply. The drawings may specify a higher pressure class or the pressure and deflection design criteria may also require a higher pressure class, but in no case should they be less than the following:

Pipe Diameter (inches)	Minimum Pressure Class (psi)
3 – 12	350
14 – 20	250
24	200
30 – 64	150

5. Pipe markings shall meet the minimum requirements of AWWA/ANSI C151/A21.51. Minimum pipe markings shall be as follows:

- a. "DI" or "Ductile" shall be clearly labeled on each pipe
 - b. Weight, pressure class and nominal thickness of each pipe
 - c. Year and country pipe was cast
 - d. Manufacturer's mark
6. Pressure and Deflection Design
- a. Pipe design shall be based on trench conditions and design pressure specified in the drawings.
 - b. Pipe shall be designed according to AWWA/ANSI C150/A21.5, AWWA/ANSI C151/A21.51, and AWWA M41 for trench construction, using the following parameters:
 - 1) Unit weight of fill (w) = 130 pcf
 - 2) Live Load = AASHTO HS 20
 - 3) Trench Depth = as indicated on drawings
 - 4) Bedding Conditions = Type 4
 - 5) Working Pressure (P_w) = 150 psi (1034.21 kPa)
 - 6) Surge Allowance (P_s) = 100 psi (689.48 kPa)
 - 7) Design Internal Pressure (P_i) = $P_w + P_s$ or 2:1 safety factor of the actual working pressure plus the actual surge pressure, whichever is greater.
 - 8) Maximum calculated deflection (D_x) = 3 percent
 - 9) Restrained Joint Safety Factor = 15 percent
 - c. Trench Depths shall be verified after existing utilities are located.
 - 1) Vertical alignment changes required because of existing utility or other conflicts shall be accommodated by an appropriate change in pipe design depth.
 - 2) In no case shall the pipe be installed deeper than it allows.
7. Provisions for Thrust Restraint
- a. Thrust at bends, tees, plugs or other fittings shall be mechanically restrained joints when required by drawings.
 - b. Thrust at bends adjacent to casing pipe shall be restrained by mechanical means through casing and for a sufficient length each side of casing.
 - c. No thrust restraint contribution shall be allowed for the restrained length of pipe within the casing.
 - d. Restrained joints, when required, shall be used for a sufficient distance from each side of the bend, tee, plug, valve or other fitting to resist thrust which will be developed at the design pressure of the pipe. For the purpose of thrust the following shall apply:

- 1) Valves shall be calculated as dead ends
 - 2) Design pressure shall be greater than the working pressure of the pipe or the internal pressure (P_i) whichever is greater.
 - 3) Restrained joints shall consist of approved mechanical restrained or push-on restrained joints.
- e. The pipe manufacturer shall verify the length of pipe with restrained joints to resist thrust in accordance with drawings, AWWA M41, and the following:
- 1) The weight of earth (W_e) shall be calculated as the weight of the projected soil prism above the pipe for unsaturated soil conditions.
 - 2) Soil density = 130 pcf (maximum value to be used for unsaturated soil conditions.
 - 3) If indicated on the drawings and the geotechnical borings that ground water is expected, account for reduced soil density.

8. Joints

- a. General – Comply with AWWA/ANSI C111/A21.11
- b. Push-On Joints
 - 1) Fastite Joint Pipe
 - 2) Tyton Joint Pipe
- c. Mechanical Joints
- d. Restrained Joints
- e. Flex-Ring Joint Pipe
- f. Lok-Ring Joint Pipe
- g. TR Flex Joint Pipe
- h. HP Lok Joint Pipe
- i. Bell restraint harnesses are not approved as restraint for ductile iron pipe joints.
- j. Shouldered Joints – ANSI/AWWA C606
 - 1) Shouldered joints shall be provided at connections to Butterfly Valves. All Butterfly Valves shall be provided with Victaulic restrained end connections. See Butterfly Valve section below. Contractor to verify prior to construction.
- k. Flanged Joints – AWWA/ANSI C115-A21.15, ASME B16.1, Class 125
 - 1) Flanged bolt circles and bolt holes shall match those of ASME B16.1, Class 125.
 - 2) Field Fabricated flanges are prohibited.

9. Gaskets

- a. All rubber joint gaskets utilized on Ductile Iron Pipe shall be in conformance with AWWA/ANSI C111/A21.11
 - b. Flanged Gaskets
 - 1) Full Face
 - 2) Manufactured true to shape from minimum 80 durometer SBR rubber stock of a thickness not less than 1/8 inch (3.18 mm)
 - 3) Virgin Stock
 - 4) Conforming to the physical and test requirements specified in AWWA C111/A21.11
 - 5) Finished Gaskets shall have holes punched by the manufacturer and shall match the flange patten in every respect
 - 6) Frayed cut edges resulting from job site gasket fabrication are not acceptable.
 - c. Furnish hydrocarbon resistant gaskets, when required.
- 10. Bolts and Nuts
 - a. See Appurtenances section in this specification.
- 11. Ductile Iron Pipe Exterior Coatings
 - a. All ductile iron pipe shall have an asphaltic coating, minimum 1 mil (0.0254 mm) thick, on the pipe exterior, unless otherwise specified on the drawings.
- 12. Ductile Iron Pipe Interior Lining
 - a. Cement Mortar Lining
 - 1) Ductile Iron Pipe for potable water shall have a cement mortar lining in accordance with AWWA/ANSI C104/A21.04 and be acceptable according to NSF 61.
 - b. Ceramic Epoxy or Epoxy Linings
 - 1) Ductile Iron Pipe for use in wastewater applications (sanitary sewer only) shall be lined with a Ceramic Epoxy or Epoxy Lining Protecto 401 Ceramic Epoxy Lining.
 - 2) Apply lining at a minimum of 40 mils (1.016 mm) DFT
 - 3) Due to the tolerances involved, the gasket area and spigot end up to 6 inches (152.4 mm) back from the end of the spigot end must be coated with 6 mils (0.1524 mm) nominal, 10 mils (0.254 mm) maximum using a joint compound as supplied by the manufacturer. Apply the compound by brush ensuring a smooth finish without excess buildup in the gasket seat or on the spigot ends.

- 4) Coat the gasket seat and spigot ends after the application of the lining.
- 5) Surface preparation shall be in accordance with the manufactures recommendations.
- 6) Check thickness using a magnetic film thickness gauge in accordance with method outline in SSPC-PA 2. Test the interior lining of all pipe barrels for pinholes with a non-destructive 2,500 volt test. Repair any defects prior to shipment.
- 7) Mark each fitting with the date of application of the lining system along with its numerical sequence of application on the date and records maintained by the applicator of his work.
- 8) For all ductile iron pipe in wastewater service where the pipe has been cut, coat the exposed surface with the touch-up material as recommended by the manufacturer.

2.02 DUCTILE IRON FITTINGS

A. Approved Manufacturers

1. American Cast Iron Pipe Company
2. McWane/Tyler Ductile
3. U.S. Pipe
4. Sigma Corporation
5. Star Pipe Products
6. EBAA Iron, Inc.
7. Approved Equivalent

B. Fittings

1. Fittings shall be in accordance with AWWA/ANSI C110/A21.10, AWWA/ANSI C153/A21.53.
2. Fittings for potable water service shall meet requirements of NSF 61.
3. Fittings for use in wastewater applications (sanitary sewer) shall be lined with a Protecto 401 Ceramic Epoxy Lining.
4. Fittings at a minimum shall meet or exceed the pressure classes of the pipe which the fitting is connected, unless specifically indicated on the drawings.
5. Fittings Markings
 - a. Meet the minimum requirements of AWWA/ANSI C151/A21.51
 - b. Minimum Markings shall include:
 - 1) "DI" or "Ductile" cast or metal stamped on each fitting

- 2) Applicable AWWA/ANSI standard for that fitting
 - 3) Pressure rating
 - 4) Number of degrees for all bends
 - 5) Nominal diameter of the openings
 - 6) Year and country fitting was cast
 - 7) Manufacturers mark
6. Joints
- a. Push-On Joints
 - 1) Comply with AWWA/ANSI C111/A21.11
 - b. Mechanical Joints
 - 1) Comply with AWWA/ANSI C111/A21.11
 - c. Mechanical Joints with mechanical restraint.
 - 1) Restraint devices shall consist of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10.
 - 2) The devices shall have the following working pressure ratings based on size and type of pipe:
 - d. Ductile Iron Pipe
 - e. 3" – 16", 350 psi (2413.17 kPa)
 - f. 18" – 48", 250 psi (1723.69 kPa)
 - g. 54", 200 psi (1378.95 kPa)
 - h. PVC C900 and C905; per Drawings; rated pressure for PVC pipe.
 - 1) Ratings are for water pressure and must include a minimum safety factor of 2:1 inch (25.4 mm) all sizes.
 - 2) Restraint devices shall have specific designs for ductile iron and PVC and should be easily differentiate between the two.
 - 3) Gland body, wedges, and wedge actuating components shall be cast from grade 65-45-12 ductile iron material in accordance with ASTM A536
 - 4) Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
 - 5) Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts.

- 6) Bell restraint harnesses shall NOT be used with Ductile iron pipe.
 - i. Push-On Restrained Joints
 - 1) Restraining Push-On Joints by means of a special gasket.
 - 2) Pressure rating shall exceed the working and test pressure of the pipeline
 - 3) Approved Manufacturers Products:
 - j. Flex-Ring Joint Pipe
 - k. Lok-Ring Joint Pipe
 - l. TR Flex Joint Pipe
 - m. HP Lok Joint Pipe
 - n. Push-On Restrained Joint bell and spigot
 - 1) Pressure rating shall exceed the working and test pressure of the pipeline
 - o. Flanged Joints
 - 1) AWWA/ANSI C115/A21.15, ASME B16.1, Class 125
 - 2) Flange bolt circles and bolt holes shall match those of ASME B16.1, Class 125
 - p. Field fabricated flanges are prohibited
7. Gaskets
 - a. See Ductile Iron Pipe
8. Bolt and Nuts
 - a. See Appurtenances section in this specification.
9. Ductile Iron Fittings Exterior Coatings
 - a. See Ductile Iron Pipe
10. Ductile Iron Fittings Interior Lining
 - a. See Ductile Iron Pipe
11. Ductile Iron Fittings Polyethylene Encasement
 - a. See Polyethylene Encasement section within this specification

2.03 POLYVINYL CHLORIDE (PVC) PIPE

- A. The PVC pipe and fittings furnished shall be of the type as specified below for each particular use or type of installation.
- B. Water Main / Force Main Piping / (4 – 14 inches (355.6 mm) in diameter):
 - 1. Use is applicable to the following applications: water mains for potable and fire protection use and any other applications indicated on the drawings.
 - 2. PVC pipe in sizes 4 – 14 inches (355.6 mm) in diameter shall conform to all applicable requirements of ANSI/AWWA C900, C905, or as applicable

or indicated in the drawings. Pipe utilized for water main shall be NSF certified for use in the transport of potable water.

3. The pipe shall meet cast iron pipe equivalent outside diameters.
4. The pipe shall meet the requirements of Table 2 of AWWA C900 or C905 as applicable.
5. The drawings may specify a higher or lower pressure class or the pressure and deflection design criteria may also require a higher pressure class:

Pipe Diameter (inches)	Minimum Pressure Class (psi)
3" – 12"	235 - DR 18
14" – 24"	165 - DR 25 (Raw Water)
	235 – DR 18 (High Service)

6. The manufacturer of each shipment of pipe may be required to supply a statement certifying that each lot or load of pipe has been subjected to the appropriate testing for PVC pipe meeting the requirements of AWWA C900 or C905, as applicable.
7. Ductile Iron Mechanical Joint Fittings (See Ductile Iron Fittings)
8. All joints shall be integral, bell and spigot gasketed joints, or plain end with rubber ring couplings. When the spigot end is to be inserted into a mechanical joint fitting, the beveled end of the pipe shall be removed prior to insertion.
9. Gaskets and lubricants shall be made from materials that are compatible with the plastic material and with each other when used together. They shall not support the growth of bacteria and for water main shall not adversely affect the potable water that is to be transported. Gaskets shall meet the requirements of ASTM F477.
10. A fabricated two part carbon steel saddle shall be used for wet tap connections. The carbon steel used in the saddle shall have a minimum yield strength of 30,000 psi (206842.80 kPa). The bolts and nuts shall be stainless steel, Type 316. The entire sleeve shall be shop coated with a minimum of 8-mils of fusion bonded epoxy in accordance with AWWA C213. No wet taps will be allowed where the outlet is the same size as the main.
11. Tapping saddles shall be installed a minimum of three feet from the edge of the saddle to any pipe joint or other saddle. Multiple taps of 6-inches or larger shall not be made in the same joint of pipe without approval of the Engineer.
12. Joint restraint systems shall be suitable for PVC pipe Joint restraint systems shall be rated for at a minimum the design pressure of the pipe with a 2 to 1 safety factor. Bell restraint harnesses are approved as restraint for PVC pipe joints. See ductile iron fittings for further requirements and list of approved manufacturers.

13. The following joint restraint are also approved for PVC pressure pipes within cased and non-cased bores:
 - a. Certa-Lok
 - b. JM Eagle-Loc
 - c. Diamond-Loc 21
 - d. Approved Equivalent
14. See Section 33 05 26 for Utility Identification requirements.
15. Pipe, fittings, and valves shall be installed in compliance with manufacturer's recommendations and in accordance with ASTM D2274.

2.04 FUSIBLE PVC FORCEMAIN:

- A. Fusible polyvinylchloride pipe for potable water or pressurized wastewater shall conform to AWWA C900, DR-18 for standard dimensionality, as applicable. Testing shall be in accordance with the referenced AWWA standards.
- B. Fusible polyvinylchloride pipe shall be extruded with plain ends. The ends shall be square to the pipe and free of any bevel or chamfer. There shall be no bell or gasket of any kind incorporated into the pipe.
- C. Fusible polyvinylchloride pipe shall be manufactured in a standard 40' nominal length or custom length as specified.
- D. Fusible polyvinylchloride pipe shall be blue in color for water.
- E. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible deleterious faults.
- F. Approved Manufacturers
 1. Fusible polyvinylchloride pipe shall be used as manufactured under the trade names Fusible C-900® , Fusible C-905®, and FPVC™, for Underground Solutions, Inc., Poway, CA, (858) 679-9551. Fusion process shall be as patented by Underground Solutions, Inc., Poway, CA, Patent No. 6,982,051.

2.05 HIGH DENSITY POLYETHYLENE (HDPE) PIPE

- A. Approved Manufacturers:
 1. J-M Manufacturing Company, Inc.
 2. Sclalrpipe.
 3. Or Approved Equal.
- B. Materials:
 1. All HDPE water pipe shall be solid wall manufactured of PE4710 resin conforming to ASTM D3350 with a cell classification of 445574C/E and

shall be a Plastic Pipe Institute TR4 listed compound and in accordance with one of the following standard specifications:

- a. AWWA C906/ASTM F714

C. Joints:

1. PE pipe shall be extruded in accordance with ASTM D1238 with plain ends.
2. The ends shall be square to the pipe and free of any bevel or chamfer.
3. There shall be no bell or gasket of any kind incorporated into the pipe.
4. HDPE shall be joined by the method of thermal butt fusion as outlined in ASTM F2620 - "Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings" or electro-fusion as outlined in ASTM F1055 - "Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing".
5. Pipe or fittings may be joined only by technicians who have been trained and qualified in the use of the equipment.

D. Minimum Pressure Class: All HDPE pipe shall have the following minimum pressure class (PC) or pressure rating (PR) or as indicated on the Drawings and elsewhere in this specification:

1. AWWA C906/PE 4710: DR-11 PR 200 psi (1378.95 kPa).
2. Pipe shall conform to Ductile Iron Pipe Size (DIPS)

2.06 VALVES

A. Gate Valves:

1. Minimum working pressure of 200 psi (1378.95 kPa).
2. Valve body and rubber-encapsulated wedge constructed of ductile iron or cast iron.
3. Resilient seat gate, bubble tight closure design.
4. Meet or exceed the ANSI/AWWA C515 standards.
5. Bronze stem and stem nut.
6. Fusion Bonded Epoxy-coated interior and exterior in accordance with AWWA C550.
7. Equipped with non-rising stem with 2-inch square operating nut, open left (counter clockwise) rotation.
8. Provide adjustable valve box, riser, and cover. Provide stem extensions for all actuators. Extension length will vary with the depth of bury for each valve and shall extend to within one (1) foot of top of valve box. Provide all necessary appurtenances for complete operation of valve.
9. Provide polyethylene encasement conforming to ANSI/AWWA C105/A21.5 for buried valves.

10. Connections: Mechanical joint.
11. Provide gaskets and stainless steel nuts and bolts. All tie rod type restraints shall be stainless steel.
12. Markings shall be cast on the bonnet or body of each valve and shall show the manufacturer's name or mark, year valve casting was made, size of valve, the letters "C515", and the designation working water pressure.
13. Manufacturer shall furnish an affidavit stating that the valve and all materials conform to the applicable AWWA requirements and all tests specified under the respective standard have been performed and have been met. Valves shall be NSF 61 certified.
14. Valves 12" and smaller shall be Waterous AFC-2500 ductile iron resilient wedge valve or approved equal and shall be supplied with a Tenor Centering Device as manufactured by American Flow Control or approved equal. Approved manufacturers for valves larger than 12":
 - a. American Flow Control
 - b. Mueller Company
 - c. Waterous Valve Company
 - d. A.P. Smith Valve Company
 - e. M & H Valve Company
 - f. American-Darling Valve
 - g. Clow Valve Company
 - h. Or approved equal

B. Butterfly Valves:

1. Approved Manufacturer.
 - a. Clow.
 - b. Crispin.
 - c. Dezurik.
 - d. Pratt.
 - e. Approved Equivalent.
2. Design:
 - a. Application: Buried with Valve Box and Cover
 - b. Class: AWWA C504 150B Butterfly Valve.
 - c. Body Material: Ductile Iron.
 - d. End Connections: Joints flanged or Victaulic per the Drawings, or Approved Equivalent.
 - e. Packing Material: NBRN
 - f. Seat Material: NBR
 - g. Disc Material: Ductile Iron with 316 Stainless Steel Edge
 - h. Shaft & Pin Material: AISI 304 Stainless Steel Shaft with AISI 316 Stainless Steel Pin

C. Valve Boxes

1. Valve boxes shall adjustable valve box, riser, cover marked "Water", one T-wrench of sufficient length, and polyethylene encasement conforming to

- ANSI/AWWA C105/A21.5 for buried valves. Valve boxes shall be provided with a valve box adaptor to ensure centering over operating nut.
2. The top of the valve boxes shall be 5 ¼ inches in diameter.
 3. Valve box height shall be suitable for the burial depth of the valve and shall have sufficient length to permit at least 6-inches of adjustment above and below grade when the valve is laid to the specified depth. Adjustment shall be screw type.
 4. Covers shall have the word "Potable Water" or "Non-Potable Water" cast on top.

D. Check Valves (inside of pipe)

1. Approved Manufacturer and type:
 - a. Tideflex Series 37G by Red Valve
 - b. Approved Equivalent.
2. Design:
 - a. Backflow preventor.
 - b. Install inside of pipe.
 - c. Maximum of 1 to 2-inch valve cracking pressure.
 - d. Size as shown on plans.
3. Material:
 - a. Elastomer: Pure Gum Rubber.
 - b. Expansion Clamp: 304 Stainless Steel.

2.07 FIRE HYDRANTS

A. Fire Hydrants

1. Dry barrel type manufactured in accordance with ANSI/AWWA C502 and UL 246 with breakaway traffic flange such that automatic, positive shut off of the hydrant is maintained if the hydrant is damaged.
2. Rated for minimum working pressure of 150 psig (1034.21 kPa).
3. Equipped with a main valve, which opens against water system pressure. Main valve shall be bronze seated and valve seat shall have a minimum 5-inch diameter opening and thread into a non-clog bronze drain ring.
4. Removable internal hydrant parts through the hydrant barrel without need for excavation.
5. Hydrant extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.
6. Provide two (2) 2-1/2 inch (64 mm) hose nozzle connections and one (1) 4-1/2 inch (114 mm) pumper nozzle connection; pumper nozzle sized to Owner's standard.
7. Counter clockwise opening rotation; hydrant operating nut for main hydrant valve.
8. All underground nuts and bolts to be type 304 stainless steel.
9. Owner's standard nozzle threads and operating nuts.

10. Provide 6-inch diameter push-on pipe joint connection and hydrant lead piping unless shown otherwise on Drawings or necessitated by field conditions.
 11. Gate valve on hydrant lead is specified separately in this section.
 12. Connect hydrants to hydrant lead piping, provide thrust restraint blocks, and, if necessary, any mechanical restraint and adapters.
 13. Finish: Primer and two coats of enamel of color required by Owner.
- B. All hydrant extensions of two (2) feet or more shall include the replacement of the standard operating rod with a one-piece larger diameter operating rod. The use of rod extenders will not be accepted without prior approval from the Engineer.
- C. Hydrants shall be Waterous Pacer or American Darling B-62-B.
- D. All fire hydrants shall be furnished with a marker matching those currently in use by the City of Hill City.

2.08 APPURTENANCES

- A. Nuts and Bolts: Buried and non-buried applications, provide AISI 304 Stainless Steel bolts and AISI 304 Stainless Steel nuts, for all nuts and bolts on fittings, valves, hydrants, and transition couplers. Properly lubricated bolts to prevent seizing.
1. Where stainless steel fasteners come in contact with aluminum, ductile iron, or other dissimilar metals, separate or isolate bolts and nuts from dissimilar metals with sleeves and washers.
 - a. Sleeves: Mylar, 1/32 inch (0.79 mm) thick, of proper size to fit bolts. One sleeve required for each bolt.
 - 1) Manufacturer:
 - a) Central Plastics Company, Shawnee, Oklahoma.
 - b) Approved Equivalent.
 - b. Washers: 63 glass phenolic, 1/8 inch (3.18 mm) thick, of proper size to fit bolts. Two washers are required for each bolt.
 2. Prior to installing nuts, coat threads of stainless steel fasteners with the following anti-seize compound to prevent galling of threads.
 - a. Manufacturers:
 - 1) Never Seez Compound Corporation, Never-Seez.
 - 2) Oil Research, Inc., WLR No. 111.
 - 3) Or Equal.
- B. Tie Bolts: Cretex Gasketed Pipe Joint Ties, or approved equivalent.
- C. Service and Tapping Saddles:
1. All stainless steel tapped outlet, band clamps, nuts, bolts, and washers.

2. Heavy gauge type 304 stainless steel shell construction, passivated welds, double bolt type with minimum band width of 6 inches (152.4 mm), and rubber "O"-ring gasket pad meeting ASTM D2000.
3. Meet or exceed the ANSI/AWWA C800 standards, 200 psig (1378.95 kPa).
4. Approved manufacturers:
 - a. Romac Industries, Inc.
 - b. Dresser Industries.
 - c. The Ford Meter Box Company.
 - d. Approved equivalent.
5. All services connecting to polyethylene pipe shall be made with polyethylene electrofusion tapping tees as manufactured by Central Plastics Company or approved equivalent.

D. Tapping Sleeve:

1. Stainless steel full wrap around body.
2. All stainless steel tapped outlet, nuts, bolts, washers.
3. Gasket to provide seal around full circumference of pipe.
4. Approved manufacturers:
 - a. Romac Industries, Inc.
 - b. The Ford Meter Box Company.
 - c. Approved Equivalent.

E. Stainless Steel Couplings:

1. All type 304 stainless steel middle ring, followers, nuts, bolts, and washers construction.
2. Minimum length as required for joining cast iron pipe sizes as shown on plans.
3. Minimum rated working pressure of 250 psi (1723.69 kPa).
4. Buna N rubber "O"-ring gaskets.
5. Approved manufacturers:
 - a. Dresser Industries, Style 38.
 - b. Approved Equivalent

F. Flanged Coupling Adapters:

1. Restrained flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
2. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restraint capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
3. The flange adapter shall be capable of deflection during assembly, or permit lengths of pipe to be field cut, to allow a minimum of 0.6" gap

between the end of the pipe and the mating flange without affecting the integrity of the seal.

4. The inner surfaces of the couplings shall be prepared for coating in accordance with the instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except the flange mating surfaces, shall be cleaned and shop primed with universal primer.
5. Approved manufacturers:
 - a. MegaFlange Series 2100.
 - b. Smith-Blair "Type 912", with anchor studs.
 - c. Approved Equivalent.

G. Transition Couplings:

1. Long pattern, sleeve type, ductile iron couplings, meeting the requirements of ANSI/AWWA C110/A21.10 and rated for 250 psig (1723.69 kPa).
2. Epoxy or nylon coated inside and out.
3. Where pipes of dissimilar metal are joined, ensure dielectric insulation to prevent galvanic corrosion.
4. Install with stainless steel bolts.
5. Provide polyethylene encasement.
6. Approved manufacturers:
 - a. Power Seal
 - b. Ford
 - c. Romac
 - d. Hymax
 - e. Approved equivalent

2.09 POLYETHYLENE ENCASEMENT

- A. Install on all underground metallic items, including: ductile iron pipe, ductile iron fittings, metal body valves, other metal pipe and fittings, fire hydrants, stainless steel couplings, transition couplings, and service and testing tapping saddles.
- B. Use only virgin polyethylene material.
- C. Encasement shall be 8 mil (0.2032 mm) linear low density (LLD) conforming to AWWA/ANSI C105/A21.5 or 4 mil (0.1016 mm) high density cross-laminated (HDCL) polyethylene encasement conforming to AWWA/ANSI C105/A21.5 and ASTM A674.
- D. Marking at a minimum of every 2 feet (60.96 cm) along its length, mark the polyethylene film with the following information:
 1. Manufacturer's name or trademark
 2. Year of manufacturer
 3. AWWA/ANSI C105/A21.5

4. Minimum film thickness and material type
5. Applicable range of nominal diameter sizes
6. Warning – Corrosion Protection – Repair any damage
7. Special Marking/Colors
 - a. Label polyethylene encasement with Water, Raw Water, or Sanitary Sewer with color in accordance with American Public Works Associate Uniform Color Code or Attach colored marking tape to the polyethylene wrap.

E. Minimum Polyethylene Tube and Sheet Sizes

Pipe Diameter (inches)	Min. Width - Flat Tube (inches)	Min. Width – Sheet (inches)
<4	14	28
6	16	32
8	20	40
10	24	48
12	27	54
14	30	60
16	34	68
18	37	74
20	41	82
24	54	108
30	67	134
36	81	162
42	81	162
48	95	190

2.10 REACTION BACKING (THRUST BLOCKS)

- A. Conform to details shown on Drawings for bends, tees, fire hydrants, dead end plug, and service tap connections.
- B. 3,000 psi (20684.28 kPa) concrete for pipe, fittings, and plugs unless specifically shown otherwise on Drawings.

2.11 BEDDING AND BACKFILLING

- A. Materials: As specified in Section 31 23 33 for backfill and pipe bedding.
- B. Aggregate Bedding: Fill Type A1 for over-excavation and Fill Type based on pipe materials as shown on the Construction Drawings and specified in Section 31 05 16.
- C. Material: Fill Type S1 or S2 as specified in Section 31 05 13.

2.12 TRENCH INSULATION

- A. Trench insulation shall be extruded rigid board material. The insulation shall have a thermal conductivity of not more than 0.28 (0.28) per hour per square foot per degree Fahrenheit per inch of thickness as tested in accordance with ASTM C177. The insulation shall not absorb moisture to an extent greater than 2.5 percent by volume as tested in accordance with ASTM D2127. The compression strength of the insulation shall be greater than 20 psi (137.90 kPa) as tested in accordance with ASTM D1621. The density of the insulation shall be between 0.9 and 1.3 pounds per cubic feet as tested in accordance with ASTM D1622.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall verify location of piping and piping systems as shown on the Drawings.
- B. Contractor shall be aware that it may be necessary to move a piping run a reasonable amount or shift it slightly up or down to avoid an existing obstruction or other piping runs. Contractor shall not receive additional compensation due to slight shift or movement of piping runs.
- C. Not all fittings may be shown on the Drawings, the fittings shown are meant to give a graphical representation only. Additional fittings required for differences in vertical and/or horizontal alignment may be required. Contractor shall not receive additional compensation due to additional fittings required to meet vertical and horizontal alignments.
- D. The Drawings show a two (2) dimensional graphical representation of the piping systems, Contractor shall note that there may need to be additional pipe length due to the vertical elevation differences that have not been represented on the drawings.
- E. All buried piping with less than six (6) feet of cover shall be insulated. Trench insulation shall be provided above the pipe with a minimum thickness of four (4) inches at the width shown on the drawings for all storm sewer crossing of pressure piping.
- F. Contractor shall provide the City of Hill City with a minimum 48 hour notice on all requests to take a watermain out of service and shall be only at off-peak times.
- G. Contractor has ability to modify the pressure pipe inverts to avoid pipe conflicts. Any deviations from the Drawings shall receive prior approval from Engineer before proceeding with the work. Minimum soil cover shall be maintained.
- H. All joints shall be properly restrained in accordance with these specifications.

- I. Contractor shall provide dewatering as necessary, piping shall not be laid in water or wet conditions.
- J. See Section 31 23 33 for all trench excavation and backfill requirements, and piping system bedding requirements.
- K. See Division 40 for all exposed process piping and valves.

3.02 PREPARATION AND STORAGE

- A. Store pipe on-site on flat surface so barrel is evenly supported. Do not stack higher than 6 feet (182.88 cm). Cover pipe with opaque material for extended storage.
- B. Remove scale and dirt on inside and outside before assembly. Inspect for damage to pipe and other materials before installation.

3.03 INSTALLATION – PIPE, VALVES, AND APPURTENANCES

- A. The type, kind, and class of pipe to be used shall be as shown on the Drawings. All pipes shall be laid and to the required line and grades.
- B. Install all pipe and appurtenances in strict accordance with manufacturer's recommendations.
 - 1. For Reinforced Concrete Pipe storm sewer, tie bolts shall be placed on the last three barrel sections and flared end section. Grout tie bolts using non-shrink masonry cement.
- C. All foreign material or dirt shall be removed from the inside of the pipe before it is lowered into its position in the trench and it shall be kept clean by approved means during and after laying.
- D. Pipe materials shall be handled carefully. Damage to protective coatings, linings, and joint fittings shall be cause for rejection of the materials. Prior to installation each pipe section, fitting, or valve shall be thoroughly inspected by the Contractor to detect damage or defects. Contractor shall inform Engineer of such damage or defects. Any defective, damaged, or gravity piping which has had its grade or joint disturbed after layer shall be replaced.
- E. Cut pipe in a neat and workmanlike manner without damaging the pipe. Cutting of pipe for connections or pipe run lengths or inserting of fittings and valves shall be done in accordance with pipe manufacturer recommendations. Rough edges shall be removed and where rubber gasket joints are used, the outer edge shall be beveled by grinding or filing to produce a smooth fit.
- F. Trench preparation shall proceed in advance of pipe installation only so far as can be backfilled the same day, or as permitted by the Owners specifications.

- G. Excavate, and backfill excavations and trenches in accordance with Section 31 23 33.
- H. Keep trenches free from surface and ground water until pipe jointing is complete.
- I. All fittings shall be set on cast in place or precast concrete blocks in order to prevent the weight from being transmitted to the pipe. Before concrete is placed around fittings and appurtenances, the appurtenance and pipe shall be wrapped with polyethylene to completely isolate the concrete from the water main construction.
- J. Form and place concrete for thrust blocking at each bend, tee, or change of direction. Thrust blocks shall bear on undisturbed earth.
- K. Securely close open ends of pipe and fittings when Work is not in progress.
- L. Pipe Installation:
 - 1. Install piping to lines, grades, and dimensions shown on Drawings.
 - 2. Take up and relay any pipe disturbed from its required grade or alignment.
 - 3. Install pipe to allow for expansion and contraction without stressing pipe.
 - 4. Install pipe such that maximum deflections from straight line or grade do not exceed manufacturer's specifications. Install bend fittings where maximum deflections are exceeded.
 - 5. Notify Engineer and Owner at least 48 hours in advance of service disruptions and connections.
- M. Prior to pipe placement the bedding conditions shall be such as to provide uniform and continuous support for the pipe. For belled pipe, bell holes shall be excavated as necessary to make the joint connections and provide proper support. Pipe shall not be laid in water or unsuitable bedding conditions. See Section 31 23 33 for bedding requirements.
- N. Piping shall be carefully lowered into laying position by the use of suitable restraining devices. The pipe shall not be dropped or dumped into the trench. All foreign matter or dirt shall be removed from the inside of the pipe and fittings before they are placed into position. Pipe joints shall be kept clean prior to and during installation. The joint surface shall be inspected prior to placement to ensure that there is no foreign matter, coating blisters, projections, rough edges, or damaged gaskets that may impact the integrity of the joint connection.
- O. As each length of pipe is placed in laying position the pipe shall be secured in place with approved backfill material and the appropriate compaction as specified in Section 31 23 33.

- P. Bell and spigot piping shall be laid with the bell ends facing upgrade and the laying shall start at the downgrade end and proceed upgrade, unless otherwise permitted by the Engineer.
- Q. When pipe laying is not in progress the open ends shall be closed by watertight plugs or other approved means. In the presence of water, the pipe end shall remain sealed until the trench has been properly drained or dewatered.
- R. At connections to existing piping, Contractor shall remove all dirt and debris that is allowed to enter the existing lines.
- S. Inspection: Do not cover pipe and fittings until all bedding, joints, and polyethylene wrap have been inspected.
- T. Replace any pipe, fittings, or appurtenances found defective after installation has been completed.
- U. PVC pipe used for force main and water main shall be installed in accordance with AWWA C605, AWWA Standard for Underground Installation of PVC Pressure Pipe and Fittings for Water.

3.04 PIPE THRUST RESTRAINT

- A. Provide all crosses, tees, bends, caps, and other thrust points in the piping system with suitable means of overcoming thrust.
- B. Concrete reaction blocking and/or retainer glands or tie rods may be used subject to the Engineer's approval. All rods, nuts, bolts, and hardware shall be stainless steel. At tees, 90 degree bends, and dead ends both mechanical type joint restraint and concrete reaction blocking shall be required.
- C. Concrete reaction blocking shall be placed so that pipe and fitting joints are accessible for repair, and in such a manner as to provide bearing against undisturbed earth. Pressure testing shall not proceed until concrete reaction blocking has reached its design strength. High early strength concrete may be used.

3.05 PVC FUSION PROCESS

- A. General
 - 1. Fusible pipe will be handled in a safer and non-destructive manner before, during, and after the fusion process and in accordance with pipe supplier's recommendations.
 - 2. Pipe will be fused by qualified fusion technicians, as documented by the pipe supplier. Training records for qualified fusion technicians shall be available to Owner or Engineer upon request.

3. Each joint fusion shall be recorded and logged by an electronic monitoring device (data logger) affixed to the fusion machine. Joint data shall be submitted as part of the As-Recorded information.
4. The fusible pipe will be installed in a manner so as not to exceed the recommended bending radius.
5. Where fusible pipe is installed by pulling in tension, the recommended Safe Pulling Force, according to the pipe supplier, shall not be exceeded.
6. Only appropriately sized, and outfitted fusion machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following properties, including the following elements:
 - a. HEAT PLATE – Heat Plates shall be in good condition with no deep gouges or scratches within the pipe circle being fused. Plates shall be clean and free of any contamination. Heater controls shall properly function, and cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's recommendations.
 - b. CARRIAGE – Carriage shall travel smoothly with no binding at less than 50 psi (344.74 kPa). Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
 - c. GENERAL MACHINE – Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.
 - d. DATALOGGER – The current version of the pipe supplier's recommended and compatible software shall be used. Protective case shall be utilized for the hand held wireless portion of the unit. Datalogger operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
7. Other equipment specifically required for the fusion process shall include the following:
 - a. Pipe rollers shall be used for support of pipe to either side of the machine.
 - b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement and/or windy weather.
 - c. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.
 - d. Facing blades specifically designed for cutting fusible polyvinylchloride pipe.

B. Joint Recording

1. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The

fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of thermoplastic pipe. The software shall register and/or record the parameters required by the manufacturer and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

3.06 POLYETHYLENE ENCASEMENT

- A. Where required all piping, fittings, valves, and appurtenances shall be fully encased in polyethylene film tubing.
- B. The polyethylene tubing shall be of appropriate size for the size of pipe being installed. Install polyethylene tubing prior to lowering pipe into trench.
- C. Tubing length shall be long enough to provide a minimum of one (1) foot overlap at all joints, fittings, and appurtenances. After completing the pipe jointing and positioning the tubing material, the overlap shall be secured into place with plastic adhesive tape wrapped circumferentially around the pipe at least three (3) full turns.
- D. The fit shall be snug over the pipe with no excess or bunched up material. Repair all rips, punctures, or other damage with taping and overlapping patching.

3.07 HYDROSTATIC TESTING OF PRESSURE MAINS

- A. Subject newly laid water main to a leakage and hydrostatic pressure test at 150 psi (1034.21 kPa) test pressure for a period of two hours. Provide test pump, pipe taps, connecting piping, test gauge and all necessary appurtenances.
- B. Fill water main with water a minimum of 24 hours before the test and expel all air from the main.
- C. Avoid development of waterhammer in pipeline.
- D. Add make-up water from a vessel of known volume whenever gauge pressure at the testing point falls 5 psi (34.47 kPa) below the required test pressure, or on a continuous basis if a suitable by-pass test pump is used, when performing the test.
- E. Pressure test service leads and laterals with water mains prior to connection to user services.
- F. Test against closed valves block to block.
- G. Locate and repair any visible leaks and any defective areas if test fails.
- H. Retest after completion of repairs.

- I. Repeat procedure until tests pass.
- J. Leakage shall not exceed the allowances indicated:

Nominal Pipe Size (inches)	Allowable Leakage in U.S. Gallons per Hour for 1000 linear feet
	Average Test Pressure in Line: 150 psi
1	0.08
1.5	0.12
2	0.17
3	0.25
4	0.33
6	0.50
8	0.66
10	0.83
12	0.99
14	1.16
16	1.32
18	1.49
20	1.66
24	1.99
30	2.48

Note: If pipeline test section includes various diameters, then allowable leakage shall be the sum of the computed leakage for the applicable lengths of each size.

- K. Operational Inspection
 - 1. Before substantial completion of the work and in the presence of the Engineer and the Contractor, representatives of the Owner shall operate all valves and hydrants to ascertain that the entire facility is in good working order; that all valve boxes are centered and valves are opened; that all hydrants operate and drain properly; that all curb boxes are plumb and centered.

3.08 DISINFECTION OF POTABLE WATER SYSTEM

- A. Flush and disinfect system in accordance with Section 33 13 00.

3.09 POTABLE WATER SEPARATION

- A. Unless otherwise specified in Contract Documents, the potable water lines shall generally be placed with the minimum specified cover. However, a greater depth may be required to clear process piping and sanitary sewers and sewer services, and no additional compensation shall be provided for such adjustments.

- B. In locations where sewer is in direct conflict with existing water main and water services the water main and water services shall be lowered to provide at least 18 inches (457.2 mm) of vertical distance between the top of the water main or service and the bottom of the sanitary or relocated in accordance with the Drawings. No additional compensation will be made for lowering the water main.
- C. Water mains crossing above process piping or sanitary sewers shall be laid to provide a separation of at least 18 inches (457.2 mm) between the bottom of the water main and the top of the sewer. When local conditions prevent a vertical separation as described, the following construction shall be used:
 - 1. Sewers passing over or under water mains shall be constructed of materials equal to water main standards of construction for a distance of at least 10 feet (304.8 cm) on either side of the water main.
 - 2. Water main passing under sewers shall, in addition, be protected by providing:
 - a. A vertical separation of at least 18 inches (457.2 mm) between the bottom of the sewer and the top of the water main.
 - b. Adequate structural support for the sewers to prevent excessive deflection of joints and settling on and breaking of the water mains.
 - c. A length of water pipe shall be centered at the point of crossing so that the joints will be equidistant and as far as possible from the sewer.
 - d. Water mains shall be laid at least 10 feet (304.8 cm) horizontally from any process piping, sanitary sewer, or storm sewer, whenever possible. When local conditions prevent a horizontal separation of 10 feet, a water main may be laid closer to sanitary sewer provided that:
 - 1) The bottom of the water main is at least 18 inches (457.2 mm) above the top of the sewer.
 - 2) Watermain must be laid in a separate trench or an undisturbed earth shelf on one side of the sewer line.
 - 3) Where this vertical separation cannot be obtained, the sewer shall be constructed of materials and with joints that are equivalent to water main standards of construction and shall be pressure tested to assure water tightness prior to backfilling.
- D. No deviation shall be made from the required line or grade except with the consent of the Engineer.

3.10 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control.

3.11 DATA FOR AS-BUILT RECORDS

- A. Record stationing and/or ties of all fittings, valves, and other underground appurtenances installed on sheets provided for such purposes by the Engineer. Include invert or centerline elevations.

END OF SECTION 33 10 00

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SECTION 33 13 00
DISINFECTION OF WATER SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Disinfection of potable water system.
 - 2. Testing and reporting results.
- B. Related Sections include, but are not limited to:
 - 1. Section 01 33 00 - Submittal Procedures.
 - 2. Section 01 45 00 - Quality Control.
 - 3. Section 01 77 00 - Closeout Procedures.
 - 4. Section 33 10 00 - Water Utilities.

1.02 REFERENCES

- A. Reference Standards include, but are not limited to:
 - 1. AWWA B300 – Standard for Hypochlorites.
 - 2. AWWA B301 – Standard for Liquid Chlorine.
 - 3. Federal Specifications BB-C-12a, O-C-114a, and O-C-602b.
 - 4. AWWA C651 – Disinfection of Water Mains.

1.03 SUBMITTALS FOR INFORMATION

- A. Submit under provisions of Section 01 33 00.
- B. Test Reports: Indicate results comparative to specified requirements

1.04 DEFINITIONS

- A. Disinfectant Residual means the concentration of disinfectant in the treated water.
- B. PPM means parts per million.

1.05 REFERENCE STANDARDS

- A. AWWA B300 - Hypochlorites; 2024.
- B. AWWA B301 - Liquid Chlorine; 2024.
- C. AWWA C651 - Disinfecting Water Mains; 2023.

1.06 QUALITY ASSURANCE

- A. Regulatory Agency Requirements: Comply with South Dakota Department of Environment and Natural Resources (SDDENR) requirements.
- B. Perform work in accordance with AWWA C651 for the disinfection of water mains.
- C. Testing Firm: Company specializing in testing potable water systems, approved by the SDDENR. Contractor shall notify the City Public Works Department to be present and observe the collection of samples for the bacteriological test. Contractor shall coordinate sampling and testing schedule with the City and the laboratory. Contractor shall pay all testing fees and lab costs.
- D. Submit bacteriologist's signature and authority associated with testing.
- E. The cleaning and disinfection work shall be conducted prior to connection to the existing water lines or to any portion that has been put into service. Unless otherwise approved, hydrostatic testing shall be completed prior to final cleaning and disinfection.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Protect against damage and contamination.
- B. Maintain caution labels on hazardous materials.
- C. Maintain storage room dry and with temperatures as uniform as possible between 60 and 80 degrees Fahrenheit (26.67 degrees Celsius).
- D. Provide necessary signs, barricades, and notices to prevent any person from accidentally consuming water or disturbing system being treated.

1.08 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 01 33 00 - Submittal Procedures and Section 01 77 00 - Closeout Procedures.
- B. Disinfection report:
 - 1. Type and form of disinfectant used.
 - 2. Date and time of disinfection.
 - 3. Test locations.
 - 4. Initial and final disinfectant residuals (quantity in treated water) in ppm for each test.
 - 5. Date and time of flushing start and completion.
 - 6. Disinfectant residual after flushing in ppm for each location test.
- C. Bacteriological report:

1. Date issued, project name, and testing laboratory name, address, and telephone number.
2. Time and date of water sample collection.
3. Name of person collecting samples.
4. Test locations.
5. Initial and final disinfectant residuals in ppm for each test location.
6. Coliform bacteria test results for each test.

PART 2 - PRODUCTS

2.01 ACCEPTABLE DISINFECTION CHEMICALS

- A. AWWA B300, Hypochlorite: Shall conform to Federal Specification O-C-114a, Type II, Grade B, or Federal Specification O-C-602b.
- B. AWWA B301, Liquid Chlorine: Shall conform to Federal Specification BB-C-120a.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Verify that piping system has been cleaned, inspected, and pressure tested.
- B. Do not start Work until conditions are satisfactory.
- C. Select one form of chlorine for use in disinfection.
- D. Flush mains thoroughly before introduction of chlorinating material. Maintain flushing velocity in main of not less than 2.5 feet (76.2 cm) per second unless the Engineer determines that conditions do not permit the required flow to be discharged to waste.

3.02 DISINFECTION OF WATER SYSTEMS

- A. Provide and attach required tools, equipment, and materials to perform the Work of this Section. Disinfectant material shall be introduced into the water system in a manner approved by the Engineer. For wells, add the required amount of chlorination material into the casing before installation of pumping equipment. Agitate as required for thorough mixing.
- B. Use of calcium hypochlorite granules for use on solvent welded plastic or on screwed joint steel pipe is prohibited because of the danger of fire or explosion from the reaction of the joint compounds with the calcium hypochlorite.
- C. Perform disinfecting in accordance with AWWA C651 prior to start-up. Coordinate with other Contractors, Engineer, and Owner.
- D. Inject treatment disinfectant into piping system to obtain 50 to 80 ppm residual.

- E. Test for disinfectant residual at each of the following locations:
 - 1. End of piping runs.
- F. Maintain disinfectant in system for 24 hours. If disinfectant residual is less than 25 ppm, repeat system treatment.
- G. All water supply and distribution mains shall be disinfected with chlorine prior to acceptance by the owner.
- H. As chlorinated water flows past new fittings and valves, related valves shall be operated so as to disinfect appurtenances and pipe branches. All valves shall be opened and closed several times during the contact period.
- I. Drain and flush using fresh water pumped through the system.
- J. Flush heavily chlorinated water from main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the system.
- K. Notify Owner and Engineer when ready for sampling so personnel from the City Public Works Department can be present during the collection of the samples for the bacteriological test.
- L. Any sections of equipment in contact with water shall be swabbed with a chlorine solution prior to installation.
- M. Properly dispose of heavily chlorinated water supply in an environmentally acceptable manner.
- N. Contractor shall pay all testing costs.

3.03 BACTERIOLOGICAL TESTING

- A. After disinfection and flushing, test water for bacteriological contamination. Samples for bacteriological analysis shall be collected by the City Public Works Department in sterile bottles obtained from the testing laboratory and submitted for testing.
- B. Samples shall be taken from the hydrants. Duplicate samples shall be collected from each hydrant.
- C. Two or more successive test samples indicating bacteriological satisfactory water shall be obtained before facility is placed into operation.
- D. If contamination is shown to be still present in the water supply, the disinfection procedure shall be repeated.
- E. All testing costs shall be paid by Contractor.

3.04 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Field inspection and testing.
- B. Samples for bacteriological analysis shall be collected in sterile bottles.
- C. Two or more successive test samples indicating bacteriological satisfactory water shall be obtained a minimum of 24 hours apart, before any system is placed into operation.

END OF SECTION 33 13 00

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SECTION 33 30 00
SANITARY SEWER UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Sanitary sewer collection piping, fittings, accessories, and bedding.
2. Sewer service piping, fittings, and appurtenances.

B. Related Sections include:

1. Section 01 45 00 - Quality Control.
2. Section 01 77 00 - Closeout Procedures.
3. Section 31 05 13 - Soils for Earthwork.
4. Section 31 05 16 - Aggregates for Exterior Improvements.
5. Section 31 23 23 - Fill and Backfill.
6. Section 31 23 33 - Trenching and Backfilling.
7. Section 33 05 13 - Manholes and Structures.

1.02 REFERENCES

A. Reference Standards include:

1. ASTM D698 - Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5 lb Rammer and 12 inch (304.8 mm) Drop.
2. ASTM D2321 - Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe.
3. ASTM D2922 - Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
4. ASTM D3017 - Test Method for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
5. ASTM D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

1.03 DEFINITIONS

- A. Bedding: Fill placed under, beside and directly over pipe, prior to subsequent backfill operations.

1.04 SUBMITTALS FOR REVIEW

- A. Section 01 33 00 - Submittal Procedures: Procedures for submittals.
- B. Product Data: Provide data indicating pipe, fittings, joints, and pipe accessories.

1.05 SUBMITTALS FOR INFORMATION

- A. Section 01 33 00 - Submittal Procedures: Procedures for submittals.
- B. Manufacturer's Instructions: Indicate special procedures required to install Products specified.
- C. Certificates: Certify that products meet or exceed specified requirements.

1.06 SUBMITTALS AT PROJECT CLOSE-OUT

- A. Section 01 78 23 - Operation and Maintenance Data.
- B. Record location of pipe runs, connections, inverts elevations, and control points.
- C. Identify, indicate, and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

PART 2 - PRODUCTS

2.01 PIPE MATERIALS

- A. PVC Pipe: ASTM D3034, SDR 26, Type PSM, Poly Vinyl Chloride (PVC) material, with rubber gasket joints.
- B. Fittings: Same material as pipe, wyes, tees, bends, elbows, ends to suit pipe joints.

2.02 PIPE ACCESSORIES

- A. Pipe Joints and Fittings: Push-on bell and spigot gasketed joints.
- B. Transition Couplings: Rubber sewer repair coupling with stainless steel bands, as manufactured by Fernco, or Approved Equivalent.

2.03 BEDDING MATERIALS

- A. Aggregate Bedding: PVC pipe bedding material as specified in Section 31 05 16.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.02 PREPARATION AND STORAGE

- A. Hand trim excavations to required elevations. Correct over excavation with Type A1 aggregate.

- B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.
- C. Store pipe on-site on flat surface so barrel is evenly supported. Stack no higher than 4 feet (121.92 cm).
- D. Inspect for damage to pipe and other materials.
- E. Store materials in a manner acceptable to Engineer.

3.03 BEDDING

- A. Excavate for pipe installation as required with Section 31 23 16 and 31 23 33 for work of this section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding material at trench bottom in accordance with Section 31 23 23 and 31 23 33, level materials in continuous layers not exceeding 6 inches (152.4 mm) compacted depth, compact to 98 percent of ASTM D698 maximum density. Bedding material shall be pipe bedding material per Specification Section 31 05 16.
- C. Maintain moisture content of bedding material at optimum to plus or minus 2 percent to attain required compaction density.

3.04 INSTALLATION – PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM D2321 or with manufacturer's instructions when appropriate. Seal joints watertight.
- B. Lay pipe true to line shown on Drawings and true to slope gradients noted on Drawings, with maximum variation from true slope of 1:1000.
- C. Install bedding at sides of pipe to minimum compacted thickness shown on Drawings; compacted to 98 percent of ASTM D698 maximum dry density.
- D. Refer to Sections 31 23 16, 31 23 23, and 31 23 33 for excavation, trenching, and backfilling requirements. Do not displace or damage pipe when compacting.
- E. Keep excavation area free from water until pipe jointing is completed. Securely close open ends of pipe and fittings when work is not in progress.
- F. Refer to Section 33 05 13 33 05 13 for manhole requirements.

3.05 FIELD QUALITY CONTROL

- A. Section 01 45 00 - Quality Control: Field inspection and testing.
- B. Request inspection prior to placing backfill above pipe.

- C. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- D. Frequency of Compaction Tests: In accordance with Section 01 45 00.
- E. Leakage Test: Test in accordance with Section 33.94 or 33.95 of the 2004 Recommended Standards for Wastewater Facilities, Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (Ten States Standards).
- F. Deflection Test: Test in accordance with Ten States Standards, Section 33.85.

3.06 PROTECTION OF FINISHED WORK

- A. Section 01 77 00 - Closeout Procedures: Protecting installed work.
- B. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 30 00

SECTION 33 40 00
STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Storm Sewer Pipe, Fittings, and Accessories.
2. Related items necessary to provide a complete installation.

B. Related sections included, but are not limited to:

1. Section 01 33 00 - Submittal Procedures.
2. Section 01 45 00 - Quality Control.
3. Section 01 51 00 - Temporary Utilities.
4. Section 01 57 00 - Temporary Controls.
5. Section 01 77 00 - Closeout Procedures.
6. Section 31 05 13 - Soils for Earthwork.
7. Section 31 05 16 - Aggregates for Exterior Improvements.
8. Section 31 23 33 - Trenching and Backfilling.

1.02 REFERENCES

A. Reference sections include, but are not limited to:

1. Standard Specifications for Road and Bridges, Latest Edition, by South Dakota Department of Transportation.
2. City of Pierre Standard Construction Specifications, latest edition.
3. ASTM F477 – Elastometric Seals (Gaskets) for Joining Plastic Pipe
4. ASTM D3212 – Joints for Drain and Sewer Plastic Pipes Using Flexible Elastometric Seals.
5. ASTM D2321 – Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity Flow Applications
6. ASTM D3350 – Polyethylene Plastics Pipe and Fittings Materials
7. ASTM A48 – Standard Specification for Gray Iron Castings
8. ASTM C478 – Precast Reinforced Concrete Manhole Sections.
9. ASTM D698 – Test Methods for Moisture-Density Relations of Soil and Soil-Aggregate Mixtures using a 5.5 lb. (2.49 kg) Rammer and a 12-inch 12 inch (304.8 mm) Drop.
10. ASTM D2922 - Test Methods for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
11. ASTM D3017 - Test Methods for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
12. ASTM C76 – Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

13. ASTM C443 – Standard Specifications for Joints for Concrete Pipes and Manholes using Rubber Gaskets.
14. ASTM C14 – Concrete Sewer, Storm Drain and Culvert Pipe.
15. ASTM C497 – Standard Test Methods for Concrete Pipe, Manhole Sections or Tile.

1.03 SUBMITTALS FOR REVIEW

- A. Shop Drawings: Indicate locations, elevations, piping, inlets, manholes, dimensions, and elevations of penetrations and storm service connections.
- B. Product Data: Provide data indicating pipe and pipe accessories.

1.04 SUBMITTALS FOR INFORMATION

- A. Manufacturer's Installation Instructions: Indicate special procedures required to install Products specified.
- B. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.05 SUBMITTALS AT PROJECT CLOSEOUT

- A. Accurately record actual locations of pipe runs, connections, manholes, inlets, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.06 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable code for materials and installation of the Work of this section.

1.08 ENVIRONMENTAL REQUIREMENTS

- A. Maintain materials and surrounding air temperature at 50 degrees Fahrenheit (10 degrees Celsius) minimum prior to, during, and 48 hours after installation of masonry Work.

PART 2 - PRODUCTS

2.01 STORM SEWER PIPE MATERIALS

- A. Storm sewer piping and pipe culverts shall be RCP or PVC as called out in the drawings and described below.
- B. Reinforced Concrete Pipe conforming to ASTM designation C76, Class III, Wall B, with Reinforced Concrete Pipe Joint Device: ASTM C443, rubber compression gasket joint. Joint type shall be tongue-and-groove. Allowable pipe lengths shall not exceed eight (8) feet and each section of pipe shall be clearly marked with the following information:
 - 1. The pipe class.
 - 2. The date of manufacture.
 - 3. The name or trademark of the manufacturer.
- C. Polyvinyl Chloride (PVC) pipe is approved for storm sewer piping less than 15-inches in diameter and shall conform to ASTM D3034, SDR 26, with rubber gasket bell and spigot joints.

2.02 ACCESSORIES

- A. Pipe Connections: Reinforced concrete pipe penetrations shall be sealed with non-shrink masonry cement premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents; capable of developing minimum compressive strength of 2,400 psi (16547.42 kPa) in 48 hours and 7,000 psi (48263.32 kPa) in 28 days
- B. Sewer Repair Couplings: Rubber couplings with stainless steel bands, as manufactured by Fernco, or Approved Equivalent.

2.03 BEDDING AND COVER MATERIALS

- A. Bedding shall be as specified in Section 31 05 16.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.
- B. Verify storm service connection pipe sizes, depths, and locations.

3.02 PREPARATION AND STORAGE

- A. Hand trim excavations to required elevations. Correct over excavation as specified in Section 31 23 33.
- B. Remove large stones or other hard matter, which could damage piping or impede consistent backfilling or compaction.

- C. Store pipe on-site on flat surface so barrel is evenly supported.
- D. Inspect for Damage to pipe and other materials.
- E. Store Materials in a manner acceptable to the Engineer.

3.03 BEDDING

- A. Excavate pipe trench in accordance with Section 31 23 33 for Work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.
- B. Place bedding and backfill per Paragraph 3.04 for RCP and DIP. Maintain optimum moisture content of bedding material to attain required compaction density.

3.04 INSTALLATION – RCP PIPE

- A. Install pipe, fittings, and accessories in accordance with ASTM C12 and manufacturer's instructions. Seal joints watertight.
- B. Lay pipe true to line and slope gradients noted on Drawings.
- C. The pipe shall be bedded and compacted to minimum standard proctor density of 98%. Bedding shall be placed up to a height equal to one-half the outside diameter of the pipe. The depth of the bedding below the pipe shall be a minimum of 4" for 27" diameter and smaller pipe, 6" for 66" diameter pipe and larger, and 5" for intermediate sizes.
- D. Refer to Sections 31 05 16, 31 23 23, and 31 23 33 for excavation, trenching, and backfilling requirements. Do not displace or damage pipe when compacting.
- E. Refer to Section 33 05 13 for manhole and inlet requirements.

3.05 FIELD QUALITY CONTROL

- A. Compaction testing:
 - 1. Perform in accordance with ASTM D698.
 - 2. If tests indicate Work does not meet specified requirements, remove Work, replace and retest. Refer to Section 31 23 23.
 - 3. Frequency of Tests: as specified in Section 31 23 23.

3.06 PROTECTION

- A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

END OF SECTION 33 40 00

DIVISION 40 PROCESS INTEGRATION

SECTION 40 27 00
PROCESS PIPING - GENERAL

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes furnishing and installation of the following, as indicated, in accordance with the provision of the Contract Documents:
 - 1. Pipe, fittings, wall pipes, and connections associated with interior Work.
- B. Related section include:
 - 1. Section 01 11 13 - Work Covered by Contract Documents
 - 2. Section 01 11 16 - Work by Owner
 - 3. Section 01 33 00 - Submittal Procedures.
 - 4. Section 01 45 00 - Quality Control.
 - 5. Section 01 61 00 - Common Product Requirements.
 - 6. Section 09 90 02 - High Performance Painting and Coating.
 - 7. Section 40 27 05 - Process Piping Support Systems.
 - 8. Section 40 27 10 - Process Piping Specialties.
 - 9. Section 40 27 20 - Process Valves.

1.02 REFERENCES

- A. Reference Standards include:
 - 1. American National Standards Institute (ANSI)
 - 2. American Society of Mechanical Engineers (ASME)
 - 3. American Society for Testing Materials (ASTM)
 - 4. American Water Works Association (AWWA)
 - 5. American Welding Society (AWS)
 - 6. National Sanitation Foundation (NSF)
 - 7. ANSI/AWWA C104/A21.4: Cement-Mortar Lining for Gray-Iron and Ductile-Iron Pipe and Fittings for water.
 - 8. ANSI/AWWA C105/A21.5: Polyethylene Encasement for Gray and Ductile Cast-Iron Piping for water and other liquids.
 - 9. ANSI/AWWA C110/A21.10: Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm through 1,219 mm), for Water.
 - 10. ANSI/AWWA C111/A21.11 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
 - 11. ANSI/AWWA C115/A21.15: Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
 - 12. ANSI/AWWA C150/A21.50: Thickness Design of Ductile-Iron Pipe.

13. ANSI/AWWA C151/A21.51: Ductile-Iron Pipe, Centrifugally Cast In Metal Molds or Sand Lined Molds for water or other liquids.
14. ASME B16.18: Cast Copper Alloy Solder Joint Pressure Fittings.
15. ASME B16.22: Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
16. ASME B16.26: Cast Copper Alloy Fittings for Flared Copper Tubes.
17. ASTM B 88: Seamless Copper Water Tube.
18. ASTM D-1784: Rigid Poly(Vinyl Chloride) Compounds and Chlorinated Poly (Vinyl Chloride) Compounds.
20. ASTM D-1785: Poly (Vinyl Chloride) (PVC) Plastic Pipe, schedules 40, 80, 120.
21. ASTM D-2464: Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
22. ASTM D-2467: Socket Type Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
23. ASTM D-2564: Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
24. ASTM D-2855: Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
25. AWWA C600: Installation of Ductile-Iron Water Mains and Their Appurtenances.
26. AWWA C606: Grooved and shouldered type joints.
27. AWWA C651: Standard for Disinfecting Water Mains.
28. AWWA C653: Disinfection of Water Treatment Plants.
29. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 In., for Water.
30. AWWA C905 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. through 48 In., for Water Transmission and Distribution.
31. NSF Standards No. 60 and 61 – National Sanitation Foundation.

1.03 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ANSI/AWS D.1.1.
- B. Employ certified welders.
- C. Piping modifications subject to Engineer's review. No additional compensation allowed for modifications required to suit equipment furnished by CMAR.

1.04 SUBMITTALS

- A. Submit Shop Drawings in accordance with Section 01 33 00 - Submittal Procedures for all pipe and fittings indicating: Name of Manufacturer, Materials, Standard Dimensions, References, and Joint Data.
- B. Submit Affidavit of Compliance for ductile iron pipe and fittings.

- C. Submit design calculations for structural design of pipe thickness where pipe class or thickness is not specifically called out.
- D. Submit detailed piping layout drawings showing piping and connections to equipment and appurtenances.

1.05 COATING AND IDENTIFICATION SYSTEMS

- A. All material and equipment in this section shall be factory primed. Primer shall be compatible with finish coats of paint provided under Section 09 90 02 - High Performance Painting and Coating.
- B. The CMAR shall refinish and restore to the original appearance all equipment that has sustained damage to the manufacturer's finish or prime coats of paint or enamel.
- C. Finish painting of all materials and equipment in this Section shall be the responsibility of the CMAR, and shall be as described Section 09 90 02 - High Performance Painting and Coating, unless otherwise specifically indicated.

1.06 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a Public Water System shall meet ANSI/NSF International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 PIPE SCHEDULE

- A. Process Piping:
 - 1. Ductile Iron.
 - 2. Stainless Steel.
 - 3. PVC.
- B. Other Piping:
 - 1. CPVC.
 - 2. HDPE.
 - 3. Copper (to be used for non-potable water system).
 - 4. Steel Pipe.
 - 5. As otherwise shown on Drawings or specified in other Sections.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Approved Manufacturers:

1. American Cast Iron Pipe Company.
2. U.S. Pipe.
3. Or approved equivalent.

B. General

1. Minimum Pressure Class (Pounds per Square Inch – PSI):
 - a. Interior and exterior exposed, flanged:
 - 1) 12-inch diameter and smaller: 350 PSI.
 - 2) 14-inch diameter and larger: 250 PSI.

C. Onsite inspection of all materials by CMAR.

1. Pipe coating:
 - a. Buried and submerged: bituminous coating (asphalt coating).
 - b. Interior and exposed: prime coat.
2. Bolts and nuts:
 - a. Buried exposed and submerged: stainless steel.
 - b. Interior and exposed: stainless steel.
3. Pipe lining:
 - a. All pipelines except air lines: cement-mortar.
 - b. Ductile iron pipe for air lines shall be unlined.
4. Submit design calculation for structural design of pipe thickness where pipe thickness or class is not specifically called out.
5. Pipe and fittings to match face and drill of valves.
6. All flanges shall be full-faced flanges.
7. All materials to be new and unused.
8. Pipe and fitting material: ductile iron.

D. Pipe: ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51.

E. Flanged Pipe: ANSI/AWWA C115/A21.15.

1. Minimum Class: Class 53.

F. Fittings:

1. Flanged fittings:
 - a. Conform to ANSI/AWWA C110/A21.10.
 - b. Full face gaskets, bolts, and nuts: AWWA C110, Appendix A.
 - c. Material: ductile iron.
2. All reducers shall be concentric pattern unless noted otherwise on the Project Drawings.

G. Coatings and Linings:

1. Asphaltic: ANSI/AWWA C110/A21.10 and ANSI/AWWA C151/A21.51.
2. Cement lining: ANSI/AWWA C104/A21.4.

3. Prime coat: Per Section 09 90 02 - High Performance Painting and Coating.
- H. Joints - Pipe and Fittings:
1. Flanged: ANSI/AWWA C110/A21.10 and ANSI/AWWA C115/A21.15. Gaskets used for air piping shall be EPDM.
 2. Provide type of joint as indicated on Project Drawings.
 3. Use of grooved and shouldered joints is acceptable where approved by Engineer.
 - a. Conform to AWWA C606.
 4. The Engineer will only accept Uni-Flanges or approved equivalent at locations that receive prior approval.
- I. Wall sleeves: Wall sleeve shall be provided where ductile iron pipe passes through concrete walls unless a wall pipe is used.

2.03 PVC PIPE AND FITTINGS

- A. PVC pipe and fittings furnished shall be of the type as specified below for each particular use or type of installation.
- B. Pressure Piping (4-inches diameter through 12-inches diameter)
1. PVC pressure pipe in sizes 4 – 12 inches in diameter shall conform to all applicable requirements of ANSI/AWWA C900 or C909 as applicable or indicated in the drawings. Pipe utilized for potable water shall be NSF certified for use in the transport of potable water.
 2. The pipe and fittings shall meet cast iron pipe equivalent outside diameters and shall be minimum Class 165 (DR25) pipe , and shall meet the requirements of Table 2 of AWWA C900 or C909 as applicable.
 3. Flanges for connecting plain end PVC pipe to equipment shall be Uni-flange series 900, ROMAC, or equal.
 4. Pipe, fittings, and valves shall be installed in compliance with manufacturer's recommendations.
- C. Pressure Piping (less than 4-inches in diameter) and Non Pressure Piping
1. Schedule 80, unless specified otherwise, conforming to ASTM D-1785.
 2. Materials: ASTM D-1784, Type 1, Grade 1.
 3. Pipe Coating:
 - a. Buried and submerged: None
 - b. Exposed and Interior: Painted as Specified in Section 09 90 02 - High Performance Painting and Coating.
 4. Fittings: ASTM D-2467, socket type; or ASTM D-2467, flange type; or ASTM D-2464, threaded type; as required or as indicated on Drawings.

5. Solvent Cement: ASTM D-2564, Primer (ASTM F656) and PVC Solvent Cement.
6. Polyvinyl chloride fittings shall be limited to a 3-inch diameter or less.

D. Perforated PVC Drain Tile Pipe

1. Perforated PVC pipe and fittings shall conform to ASTM D2729 or ASTM F949, with factory-cut, uniformly spaced perforations.
2. Pipe diameter shall be as indicated on the Drawings.
3. Pipe shall be installed to provide positive drainage away from structure footings and foundations to sump structures, drainage structures, or outlets indicated on the Drawings.
4. Install perforations downward unless otherwise indicated on the Drawings.
5. Pipe shall be installed with continuous positive slope and without low points that may trap sediment or standing water.
6. Geotextile filter sock shall be provided on all perforated drain tile unless otherwise indicated on the Drawings.
7. Drain tile system shall be protected from sediment intrusion and damage during construction activities.
8. Contractor shall verify outlet elevations and drainage paths prior to installation.
9. Damaged or crushed drain tile pipe shall be removed and replaced at no additional cost to Owner.

E. Drainage Aggregate

1. Drainage aggregate for perforated drain tile systems shall consist of clean, washed crushed stone or gravel free of fines, organic material, clay, and deleterious substances.
2. Drainage aggregate shall conform to the following gradation unless otherwise indicated on the Drawings:

Sieve Size	Percent Passing
1 Inch	100
3/4 Inch	90-100
No. 4	0-5

3. Drainage aggregate shall be placed:
 - a. Minimum 6 inches below drain tile
 - b. Minimum 12 inches above drain tile
 - c. Minimum 6 inches on each side of drain tile
4. Prevent contamination of drainage aggregate with native soils during placement.
5. Wrap drainage aggregate with nonwoven geotextile fabric where indicated on the Drawings.

F. Approved Manufacturers:

1. Georg Fischer.
2. Hayward.
3. Asahi/America.
4. Spear.

2.04 PIPE CORROSION PROTECTION

- A. Coatings: See Section 09 90 02 - High Performance Painting and Coating, for details of coating requirements.
- B. Heat Shrink Wrap:
- C. Type: Cross-linked polyolefin wrap or sleeve with mastic sealant.
- D. Manufacturer and Product: Raychem; WPC or TPS, or equal.

2.05 FLANGE INSULATING GASKET KITS

- A. Approved Manufacturer:
1. Advance Products & Systems.
 2. Approved Equivalent.
- B. Size: per diameter of flange.
- C. Pressure rating: meet minimum pressure rating of attached piping.
- D. Provide to meet either full-faced or raised faced portion of flange.
1. Full-Faced Gasket
 - a. Type E gaskets.
 - b. Precision cut bolt holes.
 - c. Material: plain face or Neoprene face phenolic.
 2. Raised Face Portion
 - a. Type F gaskets.
 - b. Inside diameter of the bolt hole circle should be slightly smaller than the outside diameter of the gasket, assuring an exact, automatic positioning of the gasket.
 - c. Material: plain face or Neoprene face phenolic.
- E. Provide insulating sleeve and washer with the single insulation sets.
1. Material: high density polyethylene (HDPE), phenolic, and Mylar.
 2. Provide with each set a 1/8" thick S.A.E. electro-plated steel washer.

2.06 COUPLINGS, TAPS, AND MISCELLANEOUS JOINTS

- A. Tapping saddles and tapping sleeves shall be Mueller, or equal.

- B. Provide pipe repair clamps where indicated on the Drawings. Pipe repair clamps shall be suitable for potable water service with all type 304 stainless steel bolts and hardware. CMAR shall verify pipe outside diameter and necessary length before placing clamp. Pipe repair clamps shall be Mueller Series 510 XTRA-RANGE Full Seal type, or equal.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Make necessary field measurements to determine pipe laying lengths; fabricate pipe; deliver pipe to site; store pipe with ends capped to prevent contamination and damage to interior; prepare pipe for installation; work pipe into place without forcing or springing.
- B. Do not store or ship small diameter pipe inside larger diameter pipe.
- C. Ream pipe and tube ends. Remove burrs. Repair lining at pipe cuts.
- D. Remove scale and dirt, inside and outside, before assembly.
- E. Remove welding slag or foreign material from pipe and fitting materials.
- F. Remove temporary preservative coatings from valves, fittings, and appurtenances prior to installation.
- G. Clean, repair, or replace equipment malfunctioning due to presence of foreign material left in piping during installation or entering piping after installation due to CMAR's work at no cost to Owner.

3.02 DUCTILE IRON PIPE AND FITTINGS

- A. Joints:
 - 1. Interior submerged: flanged.
 - 2. Interior exposed: flanged, grooved and shouldered if approved by Engineer, except where indicated otherwise on the Project Drawings.
- B. Flanged Joints:
 - 1. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.
 - 2. Care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges when bolting flanged joints.

3. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be gradually tightened and at a uniform rate, to ensure uniform compression of the gasket.
 4. Special care shall be taken when connecting piping to pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported so that accurate matching of bolt holes and uniform contact over the entire surface of the flanges is obtained before any bolts are installed in the flanges.
- C. Penetrations:
1. Install pipe straight through concrete walls or floors.
 2. Install wall pipes or sleeves as shown on Project Drawings.
 3. Fabricate wall pipes to dimensions required.
- D. Pipe and fittings to match face and drill of valves and appurtenances.

3.03 THREADED JOINTS

- A. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs.
- B. Threaded joints in plastic piping shall be made with Teflon thread tape applied to all male threads. At the option of the CMAR, threaded joints in other piping may be made up with Teflon thread tape, thread sealer, or a suitable joint compound. Thread tape and joint compound or sealers shall not be used in threaded joints that are to be seal welded.

3.04 COMPRESSION JOINTS

- A. Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past fingertight, or as recommended by the fitting manufacturer, to produce a leaktight, torque-free connection.

3.05 SOLVENT WELDED JOINTS

- A. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of

solvent welded piping systems shall not be performed until the applicable curing time, as set forth in Table X2.1 of ASTM D2855, has elapsed.

3.06 PVC PIPE

- A. Form solvent joints in PVC pipe and fittings to ANSI/ASTM D2855. Solvent joints are to be used only where threaded or flanged connections are inappropriate.
- B. 2-inch and larger: make connections to equipment and supply lines with flanges, unless otherwise specified.
- C. Under 2-inches: make connections to equipment and supply lines with solvent joints, unless otherwise specified.

3.07 DISSIMILAR PIPE CONNECTIONS

- A. Provide non-conducting connections or flange insulating gasket kits wherever joining dissimilar metals in open systems.

3.08 VENTS AND DRAINS

- A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown.

3.09 INSULATION

- A. See Section 40 42 13 - Process Piping Insulation and Heat Tracing.

3.10 TESTING

- A. Hydrostatically test each entire line in accordance with AWWA C600-99.

3.11 DISINFECTION

- A. Disinfect all potable water lines in accordance with Section 33 13 00 - Disinfection of Water Systems.

3.12 FIELD PREPARATION AND PAINTING

- A. All material and equipment in this section shall be factory primed, excluding PVC and copper, and field finish coated. Factory coatings shall be compatible with materials provided under Section 09 90 02 - High Performance Painting and Coating.

3.13 LEAKAGE

- A. All joints shall be watertight and free from leaks. All leaks shall be repaired by CMAR in a timely manner and at no expense to the Owner.

- B. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping retested by and at the expense of the CMAR.

END OF SECTION 40 27 00

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SECTION 40 27 05
PROCESS PIPING SUPPORT SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Pipe and equipment hangers, supports, and associated anchors.
2. Sleeves and seals.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures .
2. Section 09 90 02 - High Performance Painting and Coating .
3. Section 40 27 00 - Process Piping - General.
4. Section 40 27 10 - Process Piping Specialties .

1.02 REFERENCES

A. Reference Standards include:

1. ANSI B 31.10: Pipe Supports.
2. ASTM A36: Structural Steel.
3. ASTM A325: High Strength Bolts for Structural Steel Joints.

1.03 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 01 33 00. Indicate name of manufacturer, materials, standard dimensions, references, maximum loadings, and thrust restraints for all pipe support systems.
- B. Provide a list of materials and corresponding suppliers.
- C. Provide pipe support location and details with piping layout drawings for piping systems 4-inches and larger.
- D. Submit Affidavit of Compliance certifying that materials furnished have been tested and are in compliance with specification requirements.

1.04 QUALITY ASSURANCE

- A. Welding Materials and Procedures: Conform to ANSI/AWS D.1.1.
- B. Employ certified welders as necessary to complete Work.

1.05 FIELD MEASUREMENTS

- A. The Drawings indicate required pipe sizes and the general arrangement for major piping. Locations shall be verified in the field by the Contractor. Valves, fittings, and appurtenances shall be of such dimensions to allow for the installation of this piping and supports substantially as shown on the Drawings. In the event it should become necessary to change the location of any of the work due to interference with other work, Contractor shall consult with the Engineer prior to making any changes and all such changes shall be made at no additional cost to the Owner.
- B. Prior to roughing in any facilities or installation of piping and equipment, consult all related drawings including general, mechanical, electrical, etc., and inform self of materials, locations of structures, pipes, ducts, electrical conduits, etc., which may impact the installation of supports.
- C. Discrepancies discovered before or after work has started, shall be brought to the attention of the Engineer immediately, and the Engineer reserves the right to require minor changes in the work to eliminate such discrepancies.

PART 2 - PRODUCTS

2.01 PIPE HANGER SUPPORTS

- A. In certain locations, pipe supports, anchors and expansion joints have been indicated on the Drawings, but no attempt has been made to indicate every restraint, anchor, and expansion joint. It shall be the Contractor's responsibility to provide a complete system of pipe supports, to provide expansion joints, and to anchor all piping in accordance with the requirements set forth herein. Additional pipe supports may be required adjacent to expansion joints, couplings, or valves.
- B. Concrete and fabricated steel supports shall be as indicated on the Drawings, as specified in other Sections, or, in the absence of such requirements, as permitted by the Engineer.
- C. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports.
- D. Materials
 - 1. Unless otherwise specified, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the structural and miscellaneous metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.
 - 2. Unless otherwise specified or indicated on the Drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with galvanized finish or be fabricated of stainless steel.

3. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.
4. Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item.
5. Unless otherwise acceptable to the Engineer, the use of supports that rely on stressed thermoplastic components to support the pipe will not be acceptable.
6. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Supports for brass or copper pipe or tubing shall be copper plated. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated.
7. Concrete inserts or L-shaped anchor bolts shall be used to support piping from new cast-in-place concrete. Expansion anchors shall be used to fasten supports to existing concrete and masonry.
8. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as required to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as required to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints.

E. Manufacturer and Type:

1. Anvil International, Catalog PH-5.10, or approved equivalent.
 - a. Light welded steel bracket: Figure 194.
 - b. Medium welded steel bracket: Figure 195
 - c. Heavy welded steel bracket: Figure 199
 - d. Concrete Inserts: Figure 281.
 - e. Offset Pipe Clamp: Figure 103.
 - f. Adjustable Clevis Hanger: Figure 260.
 - g. Stainless Steel Hanger Rods.

2.02 FLOOR PIPE SUPPORTS

A. Approved Manufacturer and Type:

1. Anvil International, adjustable pipe saddle support: Figure 264.
2. Standon Model S92 Saddle Support.
3. PHD Manufacturing Inc., adjustable pipe saddle support. Figure 875
4. Or Approved Equivalent.

B. Minimum vertical adjustment: 4½ inch.

- C. Provide complete with riser pipe and flange bolts for floor mounting.
- D. Provide precast concrete or grout base a minimum of 1" above floor.
- E. Provide as per recommended spacing, at minimum. Contractor shall install a minimum of one floor pipe support per pump discharge piping prior to the header piping.
- F. Contractor may also be required to construct concrete saddle pipe supports for floor piping as indicated on the Drawings. Contractor to provide all materials, formwork, and labor to construct as detailed on Drawings.

2.03 WALL SUPPORTS

- A. Steel brackets shall conform to MSS Type 31 for light duty, MSS Type 32 for heavy duty, and MSS Type 33 for heavy duty. Brackets shall be sized accordingly for full size and weight of piping system. All mounting hardware shall be stainless steel.
- B. Submerged piping shall be supported with Type 316 stainless steel hangers or steel bracket supports coated with two coats of bitumastic paint.

2.04 VERTICAL PIPE SUPPORTS

- A. Two bolt riser clamps shall be MSS SP 69 Type 8 galvanized or plastic coated.
- B. Four bolt riser clamps shall be MSS SP 69 Type 42 galvanized or plastic coated.

2.05 SADDLES AND SHIELDS

- A. Protection saddles shall be MSS SP 69 Type 39.
- B. Protection shields shall be MSS SP 69 Type 40.
- C. Wood insulation saddle shall be Elcen Metal Products Company, or equal.

2.06 PREFABRICATED OR FABRICATED PIPE SUPPORTS

- A. Pre-engineered support systems constructed of steel products factory fabricated by firms regularly engaged in the manufacture of these items shall be used for this work. Steel pipe support systems shall be blasted to a white clean condition after fabrication and hot-dip galvanized in accordance with ASTM 123, unless support is specified to be fabricated of stainless steel.
- B. Free-standing pipe connections to equipment shall be firmly attached to fabricated steel frames made of angles, channels, or I-beams. Frames shall be anchored to the structure.

- C. Exterior, free-standing overhead piping shall be supported by fabricated pipe stands, made of pipe columns anchored to concrete footings, with horizontal, welded steel angles and U-bolts or clamps securing the pipes.
- D. Special pipe supports for vertical and horizontal movement shall be as detailed on the drawings. Supports shall be fabricated by firms regularly engaged in the manufacture of these items.

2.07 SLEEVES AND SEALS

- A. Wall pipes shall connect piping to concrete structure. Wall pipes shall be ductile iron meeting the requirements of AWWA C115. Provide wall pipes where indicated on Drawings.
- B. Wall sleeves shall be ductile iron meeting the requirements of AWWA C151. Sleeves shall have cast waterstop collar. Cast waterstop collar shall have an outside diameter a minimum of four inches greater than the outside diameter of the wall sleeve.
- C. Approved Manufacturers:
 - 1. Sleeves for pipes through walls and floors:
 - a. Ductile Iron Water-Stop wall pipe.
 - b. Or Approved Equivalent.
 - 2. Bolted rubber annular seal:
 - a. Link Seal manufactured by Thunderline Corp.
 - b. Or Approved Equivalent.

2.08 ANCHORS

- A. Hollow Concrete Block and Brick Anchors:
 - 1. Acceptable Manufacturer and Type:
 - a. HIT S 12/A Combi Fastener manufactured by Hilti Corporation.
 - b. Approved Equivalent.
 - 2. Accessories: HY20 Adhesive with screen tube insert.
- B. Use Type 316 stainless steel epoxy adhesive anchor bolts, Hilti 150 injection adhesive anchors, or equal, for building or structure attachments. Provide continuous concrete inserts, Unistrut P3200 series, or equal, where applicable.
- C. Mechanical anchor and powder-actuated drive-pin fasteners shall be used only with prior approval from the Engineer.

2.09 FABRICATION

- A. Size sleeves large enough to allow for installation of annular seal.
- B. Design hangers to support piping without disconnection of pipe.

2.10 FINISH

- A. Factory coat steel hangers and supports as specified in Section 09 90 02 - High Performance Painting and Coating.
- B. Touch up finish on exposed steel hangers and supports in accordance with Section 09 90 02 - High Performance Painting and Coating.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall verify location of piping and piping systems as shown on the Drawings.
- B. Pipes shall be attached to structural members when possible. When necessary to frame structural members between existing members, such members shall be provided by the Contractor at no additional cost to Owner. Structural members shall be in accordance with the building code and the guidelines of the AISC.
- C. Install hangers, supports, clamps, and attachments as required to properly support piping in all operating conditions, including thrust, water hammer and surge conditions. Supports shall allow for free expansion and contraction of the piping, and shall prevent stress on equipment. Hangers shall have a means of vertical adjustment after installation. Hangers shall be designed so that movement of the supported pipe cannot cause them to disengage. Hanger rods shall be subject to tensile loading, only.
- D. No attempt has been made to show all required pipe supports in all locations, either on the Drawings or in the details. The absence of pipe supports on the Drawings shall not relieve the Contractor of the responsibility of providing supports as required.
- E. Connections to structural framing shall not induce twisting, torsion, or later bending in the framing members. Provide supplementary steel as required.
- F. Adjust support and hanger sizes to account for pipe insulation.
- G. Meters, valves, equipment, and other point load items shall be independently supported to prevent pipe stress. Piping shall support no meters, valves, equipment or other point load items.
- H. Space supports within maximum piping span length indicated in MSS SP-69, as indicated on the Drawings, or as recommended by the pipe manufacturer, whichever spacing is less. Install additional supports at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.

- I. Supports, hangers, anchors, and guides shall be designed and provided to prevent excess heat transfer to the structure or equipment, where applicable.
- J. Risers shall be supported on each floor with riser clamps and lugs, independent of the connected horizontal piping, when possible.
- K. Do not support piping with wire, either temporarily or permanently. Do not support piping from other piping.
- L. Piping shall be supported in such a manner that neither the insulation nor the vapor/weather barrier is compromised by the support or the effects of the support.
- M. Embedded pipe supports or inserts shall be in place prior to placement of cast-in-place concrete. Continuous inserts shall be furnished with end caps and cardboard closure strips. Locate and space building attachments so that the total load and the point loads due to the pipe hanger and supports do not exceed the design capacity of the supporting structure.
- N. Where it is necessary to anchor supports to hardened concrete or completed masonry use stainless steel adhesive anchors.
- O. For precast concrete slabs, drill through concrete slab from below and provide stainless steel through bolts with square steel plates and stainless steel bolts. Plate shall bear directly upon the top surface of the precast concrete slab. All toppings or insulation as required shall be applied after installation of all support plate assemblies.
- P. Attach to structural steel with beam clamps.
- Q. Mechanical anchor and powder-actuated drive-pin fasteners shall be installed in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Non-adhesive anchors shall be only used with prior approval from the Engineer.
- R. Piping shall be supported at least one and one-half inch out from the face of walls and at least three inches below ceilings and above finished grade, unless otherwise noted.
- S. Pedestal supports shall be used where indicated on the drawings or when piping is installed at or near the floor level, and shall consist of galvanized floor flange, pipe, and saddle. Provide stainless steel anchor bolts. All pedestal supports shall be adjustable, and place up off of the floor with minimum 1-inch grout.

3.02 INSERTS

- A. Provide and install inserts for placement in concrete formwork.

- B. Provide and install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams and walls.
- C. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

3.03 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as follows:

PIPE SIZE	MAX HANGER/ SUPPORT SPACING	MIN HANGER/SUPPORT ROD DIAMETER
½ to 1-1/4 inch	6'-6"	3/8"
1-1/2 to 2 inch	10'-0"	3/8"
2-1/2 to 3 inch	10'-0"	1/2"
4 to 6 inch	10'-0"	5/8"
8 to 12 inch	10'-0"	7/8"
14 to 18 inch	10'-0"	1"
20 to 30 inch	10'-0"	1-1/2"
30 to 36 inch	10'-0"	1-3/4"
PVC (All Sizes)	5'-0"	1/2"

- B. Install supports free standing or suspended to provide minimum ½ inch space between support and adjacent Work.
- C. Place a hanger/support within 12 inches of each horizontal fitting and on each side of valves.
- D. Use hangers with 1½-inch minimum vertical adjustment.
- E. Support riser piping independently of connected horizontal piping.

3.04 THRUST ANCHORS AND GUIDES

- A. For suspended piping, center thrust anchors as closely as possible between expansion joints and between elbows and expansion joints. Anchors shall hold pipe securely and shall be sufficiently rigid to force expansion and contraction movement to take place at expansion joints and/or elbows and to preclude separation of joints.
- B. Provide thrust anchors as required to resist thrust due to changes in diameter or direction or dead end of pipelines. The design of all anchors shall be subject to approval by Engineer. Anchorage shall be required wherever bending stresses exceed allowable for pipe. Wall pipes may be used as thrust anchors.

- C. Pipe guides shall be provided adjacent to sliding expansion joints in accordance with the recommendations of the National Association of Expansion Joint Manufacturers.

3.05 INSERTS AND ANCHORS

- A. Furnish and install inserts or anchors for placement in concrete.
- B. Furnish and install inserts or anchors for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams and walls.
- C. Utilize support assemblies designed for the appropriate loads. Contractor shall verify design conditions of each piping system.
- D. Mechanical anchor and powder-actuated drive-pin fasteners shall be installed in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Non-adhesive anchors shall be only used with prior approval from the Engineer.

3.06 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Extend sleeves through floor three inches above finished floor level.
- C. Where piping penetrates floor, ceiling, or wall, close off space between pipe and sleeve with link seal.
- D. Wall sleeves and wall pipes shall be securely supported by form work to prevent contact with reinforcing steel and tie wires. Sleeves shall be set in formwork prior to pouring concrete.
- E. For precast concrete panels openings shall be provided of such size to allow at least three inches clearance around the outside of the sleeve. After installation of sleeve, grout shall be tamped into place making a watertight joint.

3.07 COATING

- A. Prime coat non-galvanized steel or non-stainless steel hangers and supports.
- B. Finish coat all hangers and supports, except galvanized and stainless steel hangers and supports, under provisions of Section 09 90 02 - High Performance Painting and Coating.

END OF SECTION 40 27 05

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SECTION 40 27 10
PROCESS PIPING SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installation of the following, as indicated, in accordance with the provision of the Contract Documents:
 - a. Mechanical Couplings
 - b. Quick Connect Couplings
 - c. Flanged Coupling Adapters
 - d. Tapping Saddles and Tapping Sleeves
 - e. Pipe Repair Clamps
 - f. Rubber Expansion Joints
 - g. Flexible PVC Wire Reinforced Hose
 - h. Wye Strainers
 - i. Buried Flange Adapters
 - j. Mechanical Joint Restraint Gland
 - k. Filler Flanges
 - l. Metal Bellows Expansion Joints/Pump Connectors
 - m. High Pressure Stainless Steel Hose
 - n. Basket-Type Line Strainer
 - o. Basket Strainers
 - p. Fire Hose
 - q. Fire Hose Spray Nozzle
 - r. Rubber Garden Hose
 - s. Bolted Link Type Seal

B. Related Sections include:

1. Section 01 11 13 - Work Covered by Contract Documents.
2. Section 09 90 02 - High Performance Painting and Coating .
3. Section 40 27 00 - Process Piping - General.
4. Section 40 27 05 - Process Piping Support Systems.
5. Section 40 27 20 - Process Valves .

1.02 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, Under Provisions of Section 01 33 00, on all materials and products specified in this Section.
- B. Provide a list of materials and corresponding suppliers.
- C. Submit Affidavit of Compliance certifying that materials furnished have been tested and are in compliance with specification requirements.

PART 2 - PRODUCTS

2.01 SPECIALTIES CONNECTIONS

- A. Provide pipe specialties suitable to connect to adjoining pipes as specified for pipe fittings. Diameter to match adjacent and adjoining piping. Contractor to coordinate and provide special pipe connections as required.

2.02 WORKING PRESSURE

- A. Working pressure of pipe specialties to be equal to working pressure of connecting pipes, unless specified otherwise.

2.03 GENERAL REQUIREMENTS

A. Mechanical Couplings

1. Bolted, sleeve type: AWWA C219-17
2. Followers: Ductile iron ATMS A536
3. Middle ring: ASTM A513, ASTM A536 or ASME SA675 GR60
4. Bolts: AWWA C111/ANSI A21.11
5. Gasket: Nitrile (Buna N)
6. Coating: Fusion-bonded epoxy
7. Working pressure: Up to 250 PSI.
8. Manufacturer and Type:
 - a. Dresser "Style 38".
 - b. Smith-Blair "441 or 411 Flexible Coupling".
 - c. Romac "Style 501" Coupling.

B. Quick Connect Couplings

1. Cam and groove design, twin arms
2. Gaskets: Nitrile (Buna N)
3. Body: 316 Stainless Steel.
4. Manufacturer and type:
 - a. OPW, Kamlock.
 - b. Ryan Herco, 1300 series.

C. Flanged Coupling Adapters

1. Fully restrained joint capability
2. Body: Ductile Iron ASTM A536
3. Gasket: Nitrile (Buna N)
4. O-ring: Nitrile (Buna N)
5. Bolts and Nuts: Carbon steel ASTM A307 electro-galvanized with dichromate seal.
6. Tees and Cross bolts: Ductile iron
7. Coating: Fusion-bonded epoxy

8. Working pressure: Up to 250 PSI.
 9. Manufacturer and type:
 - a. MegaFlange Series 2100 by EBAA Iron, Inc.
 - b. Smith Blair 912
- D. Tapping Saddles and Tapping Sleeves
1. Band shall conform to OD size ranges
 2. Stainless steel, in compliance with ASTM A240.
 3. Gasket shall provide 360-degree sealing surface, watertight.
 4. High strength bolts and nuts.
 5. Manufacturer:
 - a. Mueller
 - b. Approved Equal
- E. Pipe Repair Clamps
1. Stainless steel body.
 2. High strength stainless steel studs.
 3. Gasket shall provide 360-degree sealing surface, watertight.
 4. Manufacturer:
 - a. Mueller Series 510
 - b. Approved Equal
- F. Rubber Expansion Joints
1. Single wide filled arch rubber expansion joints.
 2. High strength limit rods and control rod plates
 3. Meets NSF standard 61
 4. Working pressure: Up to 150 PSI
 5. Manufacturers and types:
 - a. Series 230, Style 231 with limit rods and compression sleeves by Proco Products, Inc.
 - b. Invincible Style 501 with control rod assembly by Mercer Rubber Co.
- G. Flexible PVC Wire Reinforcement Hose
1. Material: PVC Hose – Heavy Duty.
 2. Reinforcement: Coated or Encased Spiral Wire.
 3. Strength: Capable of holding 100 pounds without elongation.
 4. Finish: Interior shall be smooth.
 5. Size: As shown on Drawings.
 6. Use: As shown on Drawings.
 7. Manufacturer:
 - a. Titan Hose.
- H. Wye Strainers, Water Service, 2 inches and Smaller:

1. Type: Bronze body, Y-pattern, 200 psi non-shock rated, with screwed gasketed bronze cap.
 2. Screen: Heavy-gauge Type 304 stainless steel or monel, 20-mesh.
 3. Gasket: Metal filled graphite
 4. Self-cleaning with NPT tapped outlet
 5. Manufacturer:
 - a. Armstrong International, Inc., Model F.
 - b. Mueller Steam Specialty, Model 351M.
 - c. Or Approved Equivalent.
- I. Buried Flange Adapters
1. Manufacturer:
 2. MegaFlange Series 2100 by EBAA Iron, Inc.
 - a. Approved Equivalent
- J. Mechanical Joint Restraint Glands
1. Manufacturer:
 - a. MegaFlange Series 1100 by EBAA Iron, Inc.
 - b. Approved Equivalent
- K. Filler Flanges
1. Per flanged pipe supplier recommendations
- L. Metal Bellows Expansion Joint/Pump Connectors
1. 2-ply low corrugation stainless steel bellows
 2. 300-pound class
 3. Stainless steel control rods
 4. Flanged ends
 5. Manufacturer:
 - a. Metraflex
 - b. Approved Equivalent
- M. Basket-Type Line Strainers
1. Type: Basket Strainer
 2. Flanged connections, size as shown on Drawings
 3. Working Pressure: Up to 150 PSI
 4. Body and Lid: Ductile Iron
 5. Lid: Easy top access with Buna-N O-ring
 6. Screen: Double basket design, Type 316 stainless steel, 10-mesh.
 7. Spare Parts: provide 2 baskets for each strainer
 8. Manufacturer:
 - a. Viking Lid-Ease
 - b. Or Approved Equivalent

N. Fire Hose

1. Type: Rubber covered lay flat
2. Size: 1.5 inches
3. Length: 50 ft
4. Bowl Size: 1-13/16 inches
5. Inlet Liquid Pressure: 80 PSI
6. Quantity: 4
7. Manufacturer:
 - a. Fire Hose Direct.
 - b. Or equal

O. Fire Hose Spray Nozzle

1. Type: Assault fire hose nozzle with pistol grip
2. Inlet Connection: Pipe thread inlet 1.5 inches
3. Inlet Liquid Pressure: 80 PSI

P. Rubber Garden Hose

1. Type: Commercial/Industrial rubber hose
2. Size: 5/8 inches
3. Length: 50 ft
4. Quantity: 1
5. Manufacturer:
 - a. Apex Commercial Model 8695-50
 - b. Or equal

Q. Bolted Link Type Seal

1. Standard or Fire-rated style as shown on Drawings.
2. Manufacturer:
 - a. Thunderline Corporation
 - b. Approved Equivalent

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment in locations shown on the Drawings.

3.02 MECHANICAL COUPLINGS

- A. A space of at least 1/4-inch, but not more than 1-inch, shall be left between the pipe ends.

- B. Pipe and coupling surfaces in contact with gaskets shall be clean and free of dirt and other foreign matter during assembly.
- C. All assembly bolts shall be gradually tightened and at a uniform rate, so that the coupling is free from leaks and all parts of the coupling are square and symmetrical with the pipe.
- D. The interior surfaces of the middle rings shall be prepared for coating in accordance with the instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining components shall be cleaned and shop primed with universal primer.
- E. Repair and damaged areas of shop coatings on the pipe and coupling to the satisfaction of the Engineer.
- F. Provide steel tie-bolts, diametrically opposite, which extend across the joint from lugs welded to the pipe on either side of the joint to provide restraint.

3.03 FLANGED COUPLING ADAPTERS

- A. After the pipe is in place and bolted tight, the proper locations of holes for anchor studs or lock pins shall be determined and the pipe shall be field-drilled.
- B. The inner surfaces of the couplings shall be prepared for coating in accordance with the instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The remaining surfaces, except the flange mating surfaces, shall be cleaned and shop primed with universal primer.

3.04 FILLER FLANGES

- A. Ductile iron conforming to the requirements of AWWA C115, maximum 250 psi working pressure.
- B. Match filler flange to adjoining pipe working pressure class.

3.05 RUBBER EXPANSION JOINTS

- A. Install expansion joints and control rod units per manufacturer's recommendation.

END OF SECTION 40 27 10

SECTION 40 27 20
PROCESS VALVES

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Furnishing and installation of the following, in accordance with the provisions of the Contract Documents.
 - a. Actuators
 - b. Plug Valves
 - c. Check Valves
 - d. Dual Disc Wafer Check Va
 - e. Ball Check Valves
 - f. Butterfly Valves
 - g. Ball Valves
 - h. Gate Valves
 - i. Knife Gate Valves
 - j. Pinch Valves
 - k. Needle Valves
 - l. Air Release Valves
 - m. Combination Air Valves
 - n. Solenoid Valves
 - o. Corporation Stops
 - p. Valve Extensions, Floor Stands, Universal Joints, and Guide

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures.
2. Section 01 45 00 - Quality Control.
3. Section 01 61 00 - Common Product Requirements.
4. Section 01 77 00 - Closeout Procedures.
5. Section 01 78 23 - Operation and Maintenance Data.
6. Section 09 90 02 - High Performance Painting and Coating.
7. Section 40 27 00 - Process Piping - General.
8. Section 40 27 05 - Process Piping Support Systems.
9. Division 26 – Electrical

1.02 REFERENCES

A. Reference Standards include:

1. AWWA C504: Rubber-Seated Butterfly Valves.
2. AWWA C509: Resilient-Seated Gate Valves for Waterworks Service, 2 inches through 24 inches NPS.

3. AWWA C512: Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
4. AWWA C540: Power-Actuating Devices for Valves and Sluice Gates.
5. AWWA C550: Protective Epoxy Interior Coatings for Valves and Hydrants.
6. AWWA C800: Underground Service Line Valves and Fittings.

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit in accordance with Section 01 33 00, detailed specifications, drawings, and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system. Include name of Manufacturer, references, and any additional relevant information.
- B. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 on all parts, devices, equipment and other accessories forming each complete operational system. Include a complete write-up of how the system is to operate and how to make adjustments.

1.04 REGULATORY REQUIREMENTS

- A. All products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each product.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
- B. Unless otherwise indicated, use valves suitable for 150 psi minimum working pressure.

2.02 VALVE CONNECTIONS

- A. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use full-port size valves unless otherwise specified.
- B. Thread pipe sizes 1-1/2 inches and smaller unless indicated otherwise.
- C. Flange pipe sizes 2 inches and larger unless indicated otherwise.

2.03 ACTUATORS

A. Manual Geared Actuators:

1. Type: Gear with cast iron housing. Provide chain-wheel on all valves with centerline located 6 feet and higher. Provide hand-wheel on all others requiring a manual operator.
2. Equip with adjustable open and closed position stops.
3. Provide manual gear/hand wheel actuator on all valves unless indicated otherwise on the Drawings or the valve schedule. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body shall have cast thereon the word "OPEN" and an arrow indicating the direction to open.
4. Provide riser stem and floor mounted base as indicated on the Drawings.
5. Provide position indicator.
6. Hand wheels:
 - a. Hand wheels shall be cast iron.
 - b. Maximum wheel diameter shall be 12 inches.
 - c. Maximum hand wheel pull shall be 80 pounds.
7. Chain wheels:
 - a. Chain wheels shall be galvanized, shrouded pocket hand wheels.
 - b. Provide sherardized chains.
 - c. Maximum wheel diameter shall be 12 inches.
 - d. Bolt to hand wheel type chain wheels will not be acceptable.
 - e. Maximum chain wheel pull shall be 80 pounds.
 - f. Each chain wheel operated valve shall be equipped with a chain guide which will permit rapid handling of the operating chain without "gagging" of the wheel and will also permit reasonable side pull on the chain. Suitable extensions shall be provided, if necessary, to prevent interference of the chain with adjacent piping or equipment. Operating chains shall be looped to extend within 4 feet of the floor below the valve.
8. Hand Levers:
 - a. Provide hand levers where indicated on the Drawings, or in these specifications.
 - b. Hand levers shall be directly connected to the shaft and rotate 90 degrees from full closed to full open.
 - c. Levers shall be provided with a locking device to assure positive position in full open, full closed and a minimum of five intermediate positions around the 90 degrees of rotation. Indication of valve position shall be provided.
 - d. In any building or structure containing lever operated valves, at least two operating levers shall be provided for each size and type of lever operated valve.
9. Manual Nut Operators:
 - a. Provide 2-inch AWWA-certified operating nut where indicated on the Drawings, or in these specifications.

10. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.
11. Manufacturers:
 - a. Pratt
 - b. DeZurik
 - c. Clow
 - d. Or Approved Equal

B. Electric Motor Actuators:

1. See Section 40 27 21 for electric actuator requirements.

2.04 PLUG VALVES

- A. Type of Valve: Eccentric plug valve.
- B. Body: Flanged, ASTM A126, Class B cast iron body. Bolted bonnet. Flanged valve shall be fully faced and drilled in accordance with ANSI B16.1, Class 125.
 1. Exterior Coating: Red oxide primer. Finish coat per Section 09 90 02 - High Performance Painting and Coating.
 2. Interior Coating: Epoxy suitable for potable water service or fully neoprene rubber lined.
- C. Minimum Valve Classification:
 1. 12-Inch and Smaller: 175 psi, C.W.P., non-shock working pressure rating.
 2. When plug valve is in the full open position, plug geometry and body waterway contours shall provide port area equal to 80 percent of the adjacent pipe nominal diameter and no cavities where debris can collect.
- D. Resilient Plug Facing: Neoprene. Provide dead-tight shutoff pressure in either direction.
- E. Seat: One piece welded nickel, or AISI 304L Stainless Steel.
- F. Stem Seal Packing: Nitrile-butadiene (Buna) filled PTFE U-ring seal or meet AWWA C504.

- G. Bearings: Stainless steel, permanently lubricated radial bearings. Non-adjustable thrust bearings.
- H. Manual Actuators:
 - 1. Type: Hand wheel, or gear with cast iron housing.
 - 2. Provide chain wheel on all valves located with centerline 6 feet and higher.
 - 3. Equip with adjustable open memory stop.
 - 4. Provide position indicator.
- I. Manufacturers:
 - 1. DeZurik
 - 2. Milliken
 - 3. Clow
 - 4. Pratt
 - 5. Or Approved Equal

2.05 CHECK VALVES

- A. Check Valves:
 - 1. Design: Full body, flanged type, with removable cover for removal of rubber flap disc without removal of valve from process line.
 - a. Body and Cover: Cast Iron.
 - b. Disc: Buna-N w/steel and fabric reinforcement.
 - c. Interior and Exterior coating shall be fusion bonded epoxy.
 - d. Exterior Hardware: Stainless steel bolts, nuts, and washers.
 - 2. The valve shall have full flow equal to the nominal pipe diameter at any point, through the valve. Disc stroke shall be 35 degrees. Top access port shall be full size.
 - 3. Provide a disc accelerator or spring return for rapid closure.
 - 4. Provide a screw type backflow actuator to allow opening of the valve during no flow conditions.
 - 5. Refer to Drawings and Valve Schedule for installation locations and sizes.
- B. Manufacturers:
 - 1. Series 100SR Rubber Flapper Swing Check Valve by Apco
 - 2. Surgebuster Swing Flex check Valve by Val-Matic
 - 3. Milliken Flex Check
 - 4. Crispin
 - 5. Or Approved Equal

2.06 DUAL DISC WAFER CHECK VALVES

- A. Approved Manufacturer and Type:

B. Bray/Rite Double Door Check Valve.

1. Marlin Wafer Check 125 HZNSF.
2. Stockham Duo-Check II 12HMP.
3. APCO CDD-9000AR1F.
4. Milliken Valve Series 740A.
5. Approved Equivalent.

C. Design:

1. Dual disc wafer design.
2. Body: Cast iron, ASTM A126 Grade B or ductile iron, ASTM A536.
3. Disc: ASTM B148 Alloy 952, aluminum bronze or two-piece stainless steel, ASTM Type 304.
4. Body Seat: Stainless Steel.
5. Seat Ring: Buna-N or EPDM.
6. Springs: Stainless Steel.
7. Hinge Pins: Stainless Steel.
8. Stops: Stainless Steel.
9. Bearings: Teflon.
10. End Connections: Plain, installed between ASME B.16.1, Class 125, flat faced.

D. Class 125 rating.

2.07 BALL CHECK VALVES

A. Smaller than 4-inches

1. ASTM D1784 Type I, Grade 1.
2. Body: Polyvinyl Chloride with dual union socket weld ends.
3. Rating: 150 psi at 73 degrees Fahrenheit.
4. Seat and Seal: Viton.
5. Installation: Valve shall be suitable for vertical up or horizontal flow as indicated on Construction Drawings.
6. Approved Manufacturers:
 - a. Hayward – TC Series True Union Ball Check
 - b. Spears – True Union
 - c. Nibco – Chemtrol Tru Union
 - d. ASAHI/America

B. 4-Inches and Larger

1. Body: Iron with flanged ends and cleanout and vulcanized nitrile rubber exterior.
2. Flanges: ASME B16.1, Class 125, Rated 150 pound working pressure.
3. Ball: Sinking type hollow steel.

- 4. Installation: Valve shall be suitable for vertical up or horizontal flow as indicated on Construction Drawings.
- 5. Approved Manufacturers:
 - a. FLGYT Corporation
 - b. Flomatic Corporation
- C. In addition to meeting required specifications, ball check valves shall be suitable for individual applications and shall take into consideration immediate connected piping material.

2.08 BUTTERFLY VALVES

- A. Standard: AWWA C-504, Standard for Rubber Seated Butterfly Valves.
- B. Type of Body: Flanged short body. Flanged valves shall be fully faced and drilled in accordance with ANSI Standard B16.1, Class 125.
- C. Minimum Valve Classification: 150B.
- D. Shaft: One piece Type 304 stainless steel and supported on Teflon coated stainless steel or inert nylon bearings.
- E. Shaft Seal: Self-adjusting Chevron "V"-type.
- F. Body: ASTM A126, Class B cast iron. Body wall thickness shall meet AWWA C504. Coated or plated disks are not acceptable.
- G. Seats: Acrylonitrile-butadiene material. One-piece construction and attached to valve body.
- H. Disc: One piece design. ASTM A126, stainless steel. Shaft shall pass through disc. Disc shall be retained by stainless steel pins or bolts that shall extend through the full diameter of the shaft. Disc stops within the flow stream shall be rejected.
- I. Manual Actuators:
 - 1. Type: Hand actuated, quarter turn.
 - 2. Equip with adjustable memory stops.
 - 3. Provide position indicator.
- J. Valves and actuators for SBR1-BFV1 and SBR2-BFV1 provided by SBR equipment manufacturer.
- K. Approved Manufacturers:
 - 1. Pratt
 - 2. DeZurik
 - 3. Milliken

4. American R/D

2.09 BALL VALVES

- A. Manual ball valves for use with metallic pipe systems:
 1. Manufacturer and type: Series B-6000 ball valve as manufactured by Watts Regulator Company, or approved equivalent.
 - a. Body: Bronze.
 - b. Ball: AISI Stainless Steel.
 - c. Stem: AISI Stainless Steel.
 - d. Valve Seats: Durafill.
 - e. Connection: Threaded.
- B. Manual ball valves for use with PVC pipe systems:
 1. Manufacturer and type:
 - a. Watts Regulator Company.
 - b. Hayward.
 - c. Spears.
 - d. George Fisher Inc (GF).
 2. Material: PVC.
 3. Seats: Teflon.
 4. Seals: Viton "O" rings.
 5. Stem: Blow out proof.
 6. Connector: True union.

2.10 GATE VALVES

- A. Gate valves 2-inches to 48-inches in diameter shall be resilient wedge type gate valves rated for 250 psi working pressure with all ferrous components ductile iron in accordance with ASTM A536. Gate valves 3-inches to 36-inches in diameter shall be in full compliance with the requirements of AWWA C515.
- B. Manufacturer shall provide an affidavit stating that the valve and materials conform to the applicable AWWA requirement and test specified under the respective standard have been performed and met. Valves shall be NSF 61 certified.
- C. The wedge shall be cast or ductile iron encapsulated with polyurethane rubber. The polyurethane shall be permanently bonded to the wedge.
- D. The interior of the body and bonnet shall be coated with a fused epoxy coating meeting the requirements of AWWA C550.
- E. Valves shall be non-rising stem with a 2-inch square operating nut, unless noted otherwise. All valves shall open right unless noted otherwise.

- F. Stems shall be cast bronze with integral thrust collars. The stuffing box shall be the P-ring seal type with a triple O-ring seal. The rings shall be replaceable with the valve fully open at full rated working pressure.
- G. There shall be two (2) low torque thrust washers or bearings located above and below the integral stem collar. The stem nut shall be separate and shall be of solid bronze or copper alloy.
- H. Markings shall be cast on the bonnet or body of each valve and shall show the manufacturer's name, year valve casting was made, size of valve, the letters and numbers "C515", and the designated working water pressure.
- I. Valves shall be equipped with indicators to show the position of the gate in relation to the water way.
- J. Valves shall be suitable for exposed service. All nuts, bolts, and hardware shall be stainless steel.
 - 1. Provide geared operators, unless noted otherwise. Gears shall be steel, housed in a heavy-duty cast iron grease case.
- K. Approved Manufacturers:
 - 1. DeZurik
 - 2. Mueller
 - 3. Clow
 - 4. Or Approved Equal

2.11 KNIFE GATE VALVES

- A. Bonnetless wafer body type, outside stem and yoke, rated for 150 psi, ASME B16.1 flanged ends, self-cleaning, non-clogging, with round port, resilient neoprene seat, drip tight shutoff.
- B. Wetted metal parts and stem, Type 316 stainless steel, yoke sleeve bronze, gate finish ground both sides with a sharp knife edge.
- C. Packing system leak-tight seal around the gate, valve superstructure and yoke designed for full peripheral access to gland bolts when valve is equipped with manual or power actuator.
- D. In compliance with MSS SP-81
- E. Manufacturers:
 - 1. Dezurik; Series L
 - 2. Rovang; Model L17
 - 3. ITT Fabri-Valve; Figure C67R

4. Approved Equivalent.

2.12 PINCH VALVES

- A. Valves shall be of the full cast metal body, mechanical pinch type with flange joint ends. The valve length shall be as given in ISA S75.08. The flanges shall be drilled and tapped to mate with ANSI B16.1, Class 125 / ANSI B16.5, Class 150 flanges.
- B. The sleeve trim shall be one piece construction with integral flanges drilled to be retained by the flange bolts. The sleeve trim shall be reinforced with calendared polyester fabric to match service conditions. The sleeve trim shall be connected to the pinch bar by tabs embedded in the sleeve trim reinforcing ply. All internal valve metal parts are to be completely isolated from the process fluid by the sleeve trim. For full port and reduced port sleeves the port areas shall be 100 percent of the full pipe area at the valve ends. For cone and variable orifice sleeves the port area at the inlet shall be 100 percent of the full pipe area, reducing to a smaller port size at the outlet.
- C. The solid steel pinch mechanism shall be single acting, closing the sleeve from the top only. The mechanism shall be supported in the valve body. There shall be no cast parts in the operating mechanism. The mechanism shall be connected to the electrically actuated actuator through an ACME thread stem. The electric actuator shall be as specified. The pinch mechanism shall be adjustable for stroke without removing the valve from the line.
- D. All valves shall be Red Valve, Type A, Series 5200E, or equal.
- E. Manufacturers:
 - 1. Red Valve
 - 2. Cla Val
 - 3. RF Technologies. INC.
 - 4. Or Approved Equal

2.13 NEEDLE VALVES

- A. Construction:
 - 1. Valve design shall be of the nonrotating, hardened needle type to allow positive shutoff.
 - 2. Safety back-seating needle shall seal in fully open position.
 - 3. Valve shall have a handle with square drive stem and lock nut.
 - 4. Valve shall include a shroud to protect stem threads against ingress of dirt and dust.
 - 5. Valve shall include two-piece knuckle joint to provide nonrotation of needle.

6. Joint and stem threads shall be located above the packing, protected from system media.
 7. Connections: Threaded
- B. Materials:
1. Body: AISI 316 Stainless Steel
 2. Bonnet: AISI 316 Stainless Steel
 3. Needle: S17400 SS/A564 Condition H1150D
 4. Packing, Bonnet Seals: Carbon/glass-filled PTFE
 5. Lubricant: Fluorinated base with PTFE and tungsten disulfide
 6. Bonnet seal ring, gland nut, shroud, stem, gland, handle, handle lock nut, handle washer, locking pin: AISI 316 Stainless Steel
 7. Gland lock nut: Powdered metal 300 series SS
- C. Performance:
1. Shall be capable of operating conditions of 200 degrees F and 300 PSI.
- D. Factory Testing:
1. Valves shall be factory tested with nitrogen at 1,000 psig (69 bar). Seats shall have a maximum allowable leak rate of 0.1 std cm³/min. Shell testing shall be performed to a requirement of no detectable leakage with a liquid leak detector.
- E. Manufacturers:
1. Swagelok, GU Series
 2. Or Approved Equal

2.14 AIR RELEASE VALVES (ARV)

- A. Air release valves shall allow entrained air in pipelines to escape through an air release orifice. After releasing entrained air, the orifice shall close by a needle mounted upon a compound lever mechanism actuated by a float. The orifice shall remain closed until more air accumulates and the cycle is repeated.
- B. Valves for sewage or sludge shall contain flushing and drain connections.
- C. Manufacturers:
1. Water valves shall be:
 - a. Apco
 - b. Crispin
 - c. Val-Matic
 - d. Or Approved Equal
 2. Sewage or sludge valves shall be:
 - a. Apco

- b. Crispin
- c. Val-Matic
- d. Or Approved Equal

2.15 COMBINATION AIR VALVES

- A. Type: Dual body combination air/vacuum/air release valve.
- B. Standard: AWWA C512.
- C. Material:
 - 1. Body and Cover: Ductile or Cast iron.
 - 2. Float: Stainless steel.
 - 3. Seat: Buna-N.
 - 4. Linkage: Stainless steel.
 - 5. Needle: Stainless steel.
 - 6. Other Internal Parts: Stainless steel.
- D. Function: Valve shall perform the following functions of both air release and air/vacuum valves:
 - 1. Exhaust large quantities of air during the filling of a piping system and close upon liquid entry.
 - 2. Open during draining or if a negative pressure occurs.
 - 3. Release accumulated air from a piping system while the system is in operation and under pressure.
- E. Valve shall be provided with an inlet shut-off ball valve.
- F. Manufacturers:
 - 1. Apco
 - 2. Val-Matic
 - 3. Or Approved Equal

2.16 SOLENOID VALVES

- A. Two-Way Solenoid Valves:
 - 1. Manufacturers:
 - a. ASCO Series 8210 two-way solenoid valve manufactured by Automatic Switch Company
 - b. Or Approved Equal
 - 2. Type:
 - a. Body: Stainless Steel.
 - b. Seals and Discs: Teflon.
 - c. Core Tube, Core Plugnut, Springs: Stainless steel.
 - d. Shading Coil: Copper.
 - e. Solenoid Enclosure: Watertight (NEMA 4X).

- f. Electrical: 120 Volt/1P, compatible with intended application as specified in Division 26.
- g. Provide normally open or normally closed function as coordinated with Engineer.

2.17 CORPORATION STOPS

- A. Bronze, Brass, or Stainless steel construction, inlet and outlet openings same size as the valve.
- B. AWWA ball valve type.
- C. Insta-tite or compression connections.
- D. Meet or exceed the ANSI/AWWA C800 standards, 150 psi.
- E. Approved Manufacturers:
 - 1. A.Y. McDonald Manufacturing
 - 2. Mueller
 - 3. Fork Meter Box
 - 4. Or Approved Equal

2.18 VALVE EXTENSIONS, FLOOR STANDS, UNIVERSAL JOINTS AND GUIDE

- A. General Description
 - 1. Valve extensions will be required for those locations indicated on the plans. Each extension system shall be properly sized for its intended use and method of actuation.
 - 2. All components of the valve extension shall exceed to the rated actuator torque by a factor of 1.0. Total safety factor of 2.0.
- B. Valve Extension
 - 1. Valve extension system will be as Manufactured by Penn-Troy Manufacturing or approved equal.
 - 2. Valve extensions will be a minimal diameter of 1" solid stainless steel with a 2" square nut to match specified valves.
 - 3. Couplers will be drilled and bolted together. Spaced as required by valve extension manufacturer.
 - 4. Valve extension section will be drilled and bolted together. Welding will not be permitted.
 - 5. Valve extensions steel nut, socket and couplers will be 316 cast stainless.
- C. Stem Guides
 - 1. Stem guides will be as Manufactured by Penn-Troy Manufacturing or approved equal.

2. Stem guides will be 316 cast stainless.
3. Stem guide will be field adjustable for proper alignment at installation.
4. Guides shall be placed at no more than 120 inches vertical spacing or in accordance with manufacturer's requirements as follows:
5. The slenderness ratio is the ratio of the overall length of the stem to its radius. It is recommended that support be provided so that the ratio does not exceed 200. $L = \text{length of column in inches}$ $r = \text{least radius of gyration}$. $L/r = \text{Slenderness Ratio} \leq 200$ If the ratio exceeds 200 the column is so slender that the buckling or bending mode of failure predominates over compression failure.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted (does not apply to plug valves).
- B. Install valves in the locations and configurations shown on Drawings.
- C. Provide adequate structural support of installed valves as required.
- D. Install valves per manufacturer's recommendations.

3.02 STARTING AND ADJUSTING

- A. Furnish Owner and Engineer with a written report prepared by equipment supplier certifying that equipment:
 1. Has been properly installed.
 2. Is in accurate alignment.
 3. Is free from an undue stress imposed by connecting piping, anchor bolts, etc.
 4. Has been operated through at least two complete open/close cycles.
 5. Checked for leakage

3.03 CLASSROOM AND DEMONSTRATION TRAINING

- A. Provide minimum four (4) hours classroom and demonstration training on the proper operation and maintenance of equipment. Training to be completed after completion of starting and adjusting.

3.04 PAINTING

- A. All material and equipment in this section shall be factory primed. Primer shall be compatible with finish coats of paint provided under Section 09 90 02 - High Performance Painting and Coating.

- B. Finish painting of all materials and equipment in this Section that are not concealed shall be the responsibility of the General Contractor, and shall be as described in Section 09 90 02 - High Performance Painting and Coating, unless otherwise specifically indicated. The Contractor shall, however, refinish and restore to the original appearance, all equipment that has sustained damage to the manufacturer's finish or prime coats of paint or enamel.

END OF SECTION 40 27 20

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SECTION 40 27 21
PROCESS ELECTRIC ACTUATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Furnishing and installation of the following, in accordance with the provisions of the Contract Documents.
 - a. Electric Actuators.
2. Related Sections include:
 - a. Section 01 33 00 - Submittal Procedures .
 - b. Section 01 45 00 - Quality Control .
 - c. Section 01 61 00 - Common Product Requirements .
 - d. Section 01 75 00 - Starting and Adjusting .
 - e. Section 01 77 00 - Closeout Procedures .
 - f. Section 01 78 23 - Operation and Maintenance Data .
 - g. Section 09 90 02 - High Performance Painting and Coating.
 - h. Section 40 27 00 - Process Piping - General.
 - i. Section 40 27 05 - Process Piping Support Systems.
 - j. Section 40 27 20 - Process Valves.
 - k. Section 40 27 30 - Process Gates.
 - l. Division 26 – Electrical

1.02 REFERENCES

A. Reference Standards include:

1. AWWA C540: Power-Actuating Devices for Valves and Sluice Gates.

1.03 SUBMITTALS

A. Shop Drawings and Product Data: Submit in accordance with Section 01 33 00 , detailed specifications, drawings, and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.

1. Electric Motor
2. Manufacturer's installation instructions.
3. Electric actuator installation drawings including wiring diagrams

B. Manufacturer's Instructions: Furnish under provisions of Section 01 33 00 .

1. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 on all parts, devices, equipment and other accessories forming each complete operational system. Include a complete write-up of how the system is to operate and how to make adjustments.

1.04 QUALITY CONTROL

- A. To ensure quality, conformance, and reliability with regard to the manufacturing and production of the equipment, the Manufacturer shall meet all requirements listed hereafter:
- B. Manufacturer shall have a minimum of fifteen (15) years of experience producing equipment substantially similar to that required and shall be able to submit documentation of at least fifteen (15) independent installations using the same size or larger equipment as detailed in the below. Each installation must have been in satisfactory operation for at least five (5) years.
- C. Electric actuators, and all other specified accessories and appurtenances shall be furnished by a single manufacturer or supplier to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- D. Equipment shall meet additional quality assurance requirements as specified in Section 46 05 01.
- E. Manufacturers shall meet additional qualification requirements as specified in Section 46 05 01.

1.05 REGULATORY REQUIREMENTS

- A. All products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each product.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Contractor shall transport, deliver, store, and handle as specified in Section 01 61 00 .
- B. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.

1.07 WARRANTY

- A. The Manufacturer shall warrant that all equipment shall be free of defects caused by faulty material or workmanship and shall replace those parts for at least a period of two (2) years from the date of start-up.
- B. Multiple warranties for individual components shall not be acceptable.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Actuators shall be non-intrusive, intelligent multi-turn type, suitable for use on a nominal line voltage as shown on the 'IC' Drawings and are to incorporate motor, integral reversing starter, local control facilities, and terminals for remote control and indication connections.
 - 1. Diagnostic information shall be available from both an integrally mounted display window and through non-intrusive means of reading and writing data to the actuator.
 - 2. All actuators provided on this project shall be the product of a single manufacturer.

2.02 ELECTRIC ACTUATORS:

- A. General
 - 1. Provide electric actuators where indicated on Drawings, or in these specifications.
 - 2. Complete with motor, gearing, integral reversing starters, local control facilities, local position indicator, NEMA 6 or NEMA 7 non-intrusive enclosure (based on space rating shown on Drawings), and a separately sealed terminal compartment with terminals for remote control and indication connections for indoor applications. Units shall be appropriately selected based on the rating of the room in which the unit and appurtenances are located.
 - 3. Actuator calibration shall be by integral pushbuttons and selector switch.
 - 4. Diagnostic information shall be available from an integrally mounted display window.
 - 5. Provide externally adjustable mechanical stops to prevent over travel.
 - 6. Designed to automatically actuate valve requiring one quarter turn between fully opened and fully closed positions.
 - 7. Designed for modulated position operation with solid state starter.
 - 8. Designed with torque limiting feature which prevents valve or actuator damage if any obstruction interferes with normal valve rotation, in either direction.
 - 9. Provide padlockable manual override to enable the valve to be manually operated. The override shall have clutch to disengage the motor before manual operator can be engaged. Motor operation shall automatically disengage manual drive. Engagement or disengagement of the manual drive shall be possible without damaging the actuator or valve, even with the motor running.
 - 10. Equip with limit switches to indicate open and closed positions.

11. The actuator shall have an internal 24 VDC power supply for remote control functions. The internal supplies shall be protected against overcurrent and short circuit faults. Terminals shall be included to connect the electronic controls package.
12. Modulating service operators shall be equipped with a solid-state servo positioner which accepts a 4-20 mA DC signal and positions the valve in proportion to the input signal. A 4-20mA position feedback signal shall also be provided.
13. Provide with automatic phase correction, single phase protection, instant motor reversal protection, torque switch hammer protection, and voltage spike protection.
14. Actuators are to be connected to the facility SCADA control system to enable the selection of local or remote control. See Control Loop Descriptions.
 - a. Local Position: Valve controlled by local control station supplied with valve.
 - b. Auto Position: Valve accepts positioning signal from plant control system.
15. Furnish and install manufactured base plate for each actuator.
16. Position indicators shall be provided and shall transmit a signal to the plant control system.
17. Upon loss of power, actuator and gate or valve shall remain in the position at time of power loss. Fail-safe position is not required.
18. Actuator Sizing:
 - a. Actuator shall be sized to guarantee valve/gate closure at the specified torque requirement indicated by the valve/gate manufacturer. Actuator must be adequately sized to provide the torque required to operate the valve/gate at 90% of the nominal voltage with the option of operation at up to -10% under voltage conditions.
 - b. The operating speed shall be 30 seconds (+/- 15 seconds) for open/close service and 60 seconds (+/- 15 seconds) for modulating service, unless otherwise approved by Engineer.

B. Approved Manufacturers:

1. Flowserve Limitorque MX or QX
2. Rotork IQT Series
3. Auma SQ Series
4. Approved Equivalent

C. Motors:

1. Motors shall be capable of the following cycles per hour without overload or damage:
 - a. Open/Close Service: 60 cycles per hour
 - b. Modulating Service: 1,200 cycles per hour

2. Motor type(s) allowed:
 - a. AC electric motor specifically designed for valve actuator service characterized by high starting torque, low stall torque and low inertia
 - b. 24-Volt permanent magnet motor
 3. The motor shall be 15-minute duty, Class F insulated.
 4. The motor shall be able to produce up to 150% of rated torque. The motor control shall restrict the amount of current to prevent damage to the motor, integral switching devices, or toroid transformer. A 20A fuse in the transformer secondary circuit and anti-surge fuse in the primary circuit shall provide further protection.
 5. Electrical disconnection of the motor shall be possible without loss of lubricant. The actuator must include a device to ensure that the motor runs with the correct rotation for the required direction of valve travel regardless of the connection sequence of the power supply.
 6. The actuator shall not require recalibration when motor is changed or replaced.
 7. The following criteria shall be provided for motor protection:
 - a. The motor shall be de-energized without damage in the event of a stall condition when attempting to move a jammed valve.
 - b. The motor shall be de-energized in the event of an over-torque condition.
 - c. Thermal devices (one for each phase of power) shall be imbedded in the motor windings to de-energize the motor in case of overheating.
 - d. Lost phase protection.
- D. Temperature:
1. Actuators shall be suitable for indoor and outdoor use. The actuator shall be capable of functioning in an ambient temperature ranging from 0° F to 100° F.
- E. Enclosure:
1. Actuators shall be O-ring sealed, watertight to NEMA 4X/6 and submersible to IP 68-8 (26 feet for 96 hours) in accordance with EN 60529. All external fasteners shall be of stainless steel. An anti-condensation heater shall be installed inside the actuator, suitable for continuous operation.
- F. Internal Wiring:
1. For ease of maintenance and repair, all internal wiring shall be terminated at a plug and socket connector.
- G. External Wiring:

1. External wiring shall terminate in a removable plug and socket head, which allows easy disconnection of all power and control voltages. Actuators furnished without plug and socket terminal connections must have power and control disconnect switches for ease of maintenance and safety.

H. Gearing:

1. The actuator gearing shall be totally enclosed in a grease-filled cast iron gear case suitable for operation in any orientation. Gearing shall be hardened steel with alloy bronze worm wheel. Where required per application, electric actuators will be provided with worm gearboxes. The worm gearboxes shall be supplied with end-of-travel mechanical stops.

I. Manual Operation:

1. Manual bypass operation shall be required on all electric actuators. Manual operation shall be by handwheel, which shall be removable and which shall not rotate during motor operation. The declutching from motor operation shall be at the motor shaft to minimize declutching effort. The amount of force required to declutch the actuator shall be the same regardless of size of the actuator. Return from manual to electric mode of operation will be automatic upon motor operation. A seized or inoperable motor shall not prevent manual operation.

J. Valve Position and Torque Calibration:

1. Position and torque shall be sensed by absolute encoder using hall effect sensors. Position and torque settings will be stored in permanent non-volatile memory.
2. Torque adjustment shall be adjustable between 40% and 100 % or rated torque.
3. Torque switch bypass to be provided for the torque sensing system to inhibit torque switch trip during unseating or during starting in mid-travel against high inertia loads.

K. Actuator Controls:

1. Actuator Status Indication:
 - a. Six contacts shall be provided. The contacts shall have a minimum rating of 5A, 250VAC.
 - b. One contact dedicated for collective fault (e.g., phase failure, motor protection tripped, torque fault).
 - c. Five additional indication contacts selectable from a list of parameters including, but not limited to: end position CLOSED, end position OPEN, selector switch in REMOTE mode, torque fault in CLOSED direction, and torque fault in OPEN direction.

L. Integral Starter and Transformer:

1. Starter shall be suitable for the following starts per hour:
 - a. Up to 60 starts per hour for open/close service
 - b. Up to 1,200 starts per hour for modulating service
2. All modulating actuators shall be equipped with a solid state starter.
3. Control power shall be provided from an integral 24 VDC supply unless a separate power source is shown on the Electrical drawings.

M. Control Module:

1. A control module shall be provided for position modulating type service. The control module shall be mounted within the valve actuator limit switch housing. The module shall accept a standard 4-20 mA dc analog input signal with load impedance of not greater than 400 ohms. The control module shall contain adjustments for span, zero, gain, and deadband.
2. The actuator shall include local Open/Stop/Close pushbuttons and a Local/Off/Remote selector switch lockable in any of the three positions.
3. It shall be possible to select maintained or non-maintained control independently for either the local or remote modes.
 - a. When the actuator selector switch is in the "remote" position, the valve shall be capable of being positioned remotely using an integral comparator circuit and a 4-20 mA input signal from a remote source.
 - b. When the selector switch is in the "local" position, the valve shall be capable of being positioned locally using the integral pushbutton.
4. It shall be possible to program the output direction of the actuator (clockwise or counterclockwise to close) without removal of any covers.
5. It shall be possible to re-orient local pushbutton controls in 90° increments.

N. Control Performance:

1. For any operating torque within the specified range of the valve actuator, the valve and actuator shall perform within these specified limits:
 - a. Linearity: Linearity of actual valve position as compared to demand signal shall be within plus or minus 4.0 percent of span over the entire operating range.
 - b. Repeatability: For any repeated demand signal to the valve actuator, the actual valve position shall be repeated within 0.5 percent of span.
 - c. Deadband: Deadband of the valve actuator shall be adjustable from 1.0 to 10 percent of span.
 - d. Hysteresis: For any repeated demand signal to the valve actuator, from either an increasing or a decreasing direction, the actual valve position shall be repeated within 1 degree of valve shaft rotation.

- O. Control Capabilities (Contact Closure / Discrete Signals):
1. The following control capabilities must be available:
 - a. Input remote control signals for:
 - 1) Open/Stop/Close (maintained contacts) or emergency
 - 2) Open/Close 'push to run' (momentary)
 - 3) Programmable emergency input for fail to any intermediate or end of travel positions when required
 2. Programmable electronic torque switch bypass initialized in end and intermediate positions.
 3. Separate open and close direction pulse timer (stepping mode) circuits capable of initializing at any position (open, close or intermediate).
 4. It shall be possible to reverse valve travel without the necessity of stopping the actuator.
- P. Control Capabilities (Analog Signals):
1. The following control capabilities must be available:
 - a. Provide controls for an analog input (4-20mA) percent position, and provide an output with a 4-20mA percent feedback.
 - b. Provide programmable emergency input for fail to any intermediate or end of travel positions when required.
- Q. Non-Intrusive Capability:
1. In order to maintain the integrity of the enclosure, setting of all actuator parameters including the torque levels, position limits, configuration of the indication contacts and positioner functionality shall be accomplished without removing covers from the actuator control assemblies or housing. Settings shall be made by entering the set up mode and following menu prompts appearing in the LCD window. Set up shall be accomplished by using the actuator integral selector switch and pushbuttons or with a hand-held setting device. Actuator parameters may also be set by means of laptop computer via a two-way information infrared interface or laptop via Bluetooth® interface.

2.03 ACTUATOR SCHEDULE

- A. Provide actuators according to the following schedule.

TABLE 1: ACTUATOR SCHEDULE					
TAG #	VALVE SIZE	VALVE TYPE	P&ID SHEET	SERVICE	ELECTRICAL SERVICE
DVM-SLG1	12"X16"	SLIDE GATE	IC101	MODULATING W/POSITION	480VAC/3PH

				INDICATOR	
RLS-PIV1	8"	PINCH VALVE	IC101	MODULATING W/POSITION INDICATOR	120VAC/1PH
CLF-PIV1	8"	PINCH VALVE	IC107	MODULATING W/POSITION INDICATOR	120VAC/1PH
PB4-BFV2	8"	BUTTERFLY VALVE	IC117	MODULATING W/POSITION INDICATOR	120VAC/1PH
PB4-BFV3	8"	BUTTERFLY VALVE	IC118	MODULATING W/POSITION INDICATOR	120VAC/1PH

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install actuator on gate or valve per manufacturer's recommendations.
- B. Install actuators in the locations shown on Drawings. Verify configuration with Owner and Engineer.
- C. Provide adequate structural support of installed actuators and valves as required.
- D. Valve tags to be installed so as not to interfere with valve or actuator operation.

3.02 PAINTING

- A. All material and equipment in this section shall be factory primed. Primer shall be compatible with finish coats of paint provided under Section 09 90 02 - High Performance Painting and Coating.
- B. Finish painting of all materials and equipment in this Section that are not concealed shall be the responsibility of the General Contractor, and shall be as described in Section 09 90 02 - High Performance Painting and Coating. Painting, unless otherwise specifically indicated. The Contractor shall, however, refinish and restore to the original appearance, all equipment that has sustained damage to the manufacturer's finish or prime coats of paint or enamel.

3.03 STARTUP AND ADJUSTING

- A. Provide services of an Experienced, Competent and Authorized Representative of Manufacturer for a minimum of eight (8) hours:
 - 1. Inspect equipment covered by these Specifications.
 - 2. Supervise any adjustments and installation checks.
 - 3. Conduct start-up of equipment and perform operation checks and tests.

4. Reference Sections 01 45 00 and 01 75 00 for additional requirements.
- B. Furnish Owner and Engineer with a written report prepared by equipment supplier certifying that equipment:
 1. Has been properly installed.
 2. Is in accurate alignment.
 3. Is free from an undue stress imposed by connecting piping, anchor bolts, etc.
 4. Has been operated through at least two complete open/close cycles.
- C. Each actuator must be tested and individual test certificates shall be supplied free-of-charge. The test equipment should simulate a typical valve load and the following parameters should be recorded:
 1. Current at maximum torque setting
 2. Torque at maximum torque setting
 3. Actuator Output Speed or Operating Time
- D. In addition, the test certificate should record details of specification, such as gear ratios for both manual and automatic drive, closing direction, and wiring diagram.
- E. Contractor shall perform testing, startup, and adjustments as specified in Section 01 75 00 .

3.04 COMMISSIONING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.

3.05 CLASSROOM AND DEMONSTRATION TRAINING

- A. Follow the requirements in Section 01 79 00.
 1. Provide minimum four (4) hour of classroom training and four (4) hours of demonstration training by a qualified manufacturer's representative.
- B. Contractor shall record training via digital video camera so Owner can use again in the future.

3.06 SPARE PARTS

- A. Furnish lubricating materials to allow for one year of operation. Lubricating materials shall be as recommended by the manufacturer.

END OF SECTION 40 27 21

SECTION 40 27 30
PROCESS GATES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Furnishing and installation of the following equipment in accordance with the provisions of the Contract Documents:
 - 1. Slide Gates
 - 2. Slide Plates / Stop Plates
- B. Related Sections include:
 - 1. Section 01 33 00 - Submittal Procedures .
 - 2. Section 01 45 00 - Quality Control .
 - 3. Section 01 61 00 - Common Product Requirements .
 - 4. Section 01 75 00 - Starting and Adjusting .
 - 5. Section 01 77 00 - Closeout Procedures .
 - 6. Section 01 78 23 - Operation and Maintenance Data .
 - 7. Section 40 27 00 - Process Piping - General.
 - 8. Section 40 27 20 - Process Valves .
 - 9. Section 40 27 21 - Process Electric Actuators .

1.02 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00, detailed specifications, drawings, certified test results, and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.
 - 1. Layout and installation drawings for each gate size and type.
 - 2. Gate operators
 - 3. Wall thimbles
 - 4. Manufacturer's installation instructions.
 - 5. Technical manuals
 - 6. Parts list and list of recommended spare parts
 - 7. Printed warranty
 - 8. Design Calculations: Submit calculations and design data substantiating conformance with the Drawings and Specifications.
- B. Manufacturer's Instructions: Furnish under provisions of Section 01 33 00.
- C. Manufacturer's Field Service Reports: Furnish, under provisions of Section 01 33 00, reports covering start up, demonstration, and instructions.

- D. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 on all parts, devices, equipment, and other accessories furnished forming the complete operational system. Include a complete write-up of how the system is to operate and how to make adjustments.

1.03 SYSTEM DESCRIPTION

- A. Provide slide gates and weir gates in the sizes and locations shown, complete and operable, including operators, bracing, frame, mountings, and all related appurtenances where shown on the Drawings.

1.04 QUALITY ASSURANCE

- A. The equipment supplier must have at least five (5) continuous years of experience in the design, application and manufacture of stainless steel slide and weir gate assemblies. All material and equipment shall be new and of the highest quality.
- B. Gates and all other specified accessories and appurtenances shall be furnished by a single manufacturer or supplier to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- C. In order to assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these specifications that all slide and weir gate assemblies and accessories called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- D. The gates and appurtenances shall be supplied in accordance with the latest edition of AWWA C561 Standard for Fabricated Stainless Steel Slide Gates as modified herein.
- E. Gates shall be shop inspected, tested for operation and leakage and adjusted before shipping
- F. Gates shall be tested at a location within continental North America.

1.05 DELIVERY STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Owner until required for installation. Materials shall be stored in accordance with manufacturer's instructions and the requirements of section 01 61 00.
- B. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.

1.06 WARRANTY REQUIREMENTS

- A. The equipment manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of five (5) years under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Slide Gates / Weir Gates / Slide Plates / Weir Plates:
 - 1. Whipps
 - 2. Fontaine
 - 3. Golden Harvest
 - 4. Rodney Hunt/JASH
 - 5. Hydro Gate
 - 6. Waterman Industries
 - 7. Approved equal

2.02 DESIGN REQUIREMENTS

- A. Slide Gate / Weir Gate / Stop Plate Leakage Requirements
 - 1. Under a design seating head of less than 20 ft. (measured from gate invert) the leakage shall not exceed 0.1 gallons per minute per foot of seating perimeter.
- B. The slide gates shall be either self-contained or the non-self-contained type as indicated on the Construction Drawings with the guides designed to mount on the face of the concrete wall or embedded in the channel wall.
- C. Gates which have a width equal to or exceeding twice the slide height shall be furnished with tandem interconnected operators with a single input crank.
- D. Gates shall be all extruded aluminum alloy, Type 304 or 316 stainless steel construction with minimum structural component and disc thicknesses of 1/4-inch.
- E. All components of the gate shall be designed to withstand the maximum head indicated on the plans and in the seating and unseating directions and the maximum output of the hoist. The design stresses shall not exceed the lesser of 40% of the yield strength or 25% of the ultimate strength of the materials for maximum load conditions.

- F. Minimum thickness of slide and all structural members of slide or frame below the operating floor shall be ¼-inch for gates up to and including 60-inches wide, and 3/8-inch for gates wider than 60 inches.

2.03 SLIDE GATE / WEIR GATE MATERIALS

- A. Frame, guides, slide, stem couplings, stem guides, retainer bars, yoke shall be ASTM A276 Type 304 or 316 stainless steel construction. Metal components not listed shall be ASTM A276 Type 304 or 316 stainless steel construction.
- B. Threaded stems shall be 303MX stainless steel.
- C. Seating surfaces including seals and stem guide liner shall be ASTM D-4020-96, ultra high weight molecular polyethylene (UHMWPE).
- D. Compression cord shall be nitrile or EPDM (as per ASTM 2000).
- E. Guides shall be 304L or 316 stainless steel construction. Bushings shall be UHMWPE.
- F. Bottom seals shall be neoprene.
- G. Gaskets shall be EPDM.
- H. Fasteners shall be 316 stainless steel.
- I. Lift nut and couplings shall be manganese bronze.

2.04 SLIDE GATE / WEIR GATES

- A. Gates shall be self-contained or non-self-contained, pipe flange-mounted, embedded or wall-mounted, upward opening or downward opening.
- B. The gate disc shall consist of a flat plate reinforced with structural or formed members welded to the plate. The disc is to be designed to limit deflection of the gate to 1/720 of its span.
- C. The gate frame shall consist of guides, invert member and, if self-contained, an operator yoke welded or bolted together to form a rigid one-piece frame. The guides shall be of a sandwiched type construction built of plates, angles and formed shapes. The guide slot shall engage the disc plate a minimum of 1". The invert members shall be of an angle, channel or formed shaped welded to the bottom of the guide to form a flush surface and to meet with the disc seal. For self-contained gates the yoke member shall be designed for the maximum output of the gate hoist. Yoke members to be designed to limit the deflection to 1/360 of its span.
- D. Yoke shall be designed to allow removal of the disc without removal of the yoke.

1. Yoke and stem of pipe flange-mounted, self-contained, rising stem gates shall allow for installation of a floorstand pedestal and floorstand-mounted electric actuator atop yoke.
 2. Gate manufacturer shall provide floorstand pedestal compatible with gate and electric actuator.
- E. Frame shall be equipped with UHMW polyethylene bearing strips which contact the disc face to reduce operating friction. UHMW strips shall be mechanically retained to lock seat in place.
- F. The bottom seal shall be made of resilient EPDM set into a bottom member of the frame and shall form a flush bottom.
- G. Provide appropriate frame for upward opening and downward opening gates.
- H. Provide flush mounting with bottom of channel or opening.
- I. Frame shall be suitable for mounting on a concrete wall using a flange backing, or suitable for embedment in a concrete channel. EPDM gasket shall be provided for flangeback mounting.
- J. The guides shall be made of UHMWPE and shall be of such length as to retain and support at least two-thirds (2/3) of the vertical height of the slide in the fully open position.
- K. Side and top seals shall be made of UHMWPE of the self-adjusting type. A continuous compression cord shall ensure contact between the UHMWPE guide and the gate in all positions. The sealing system shall maintain efficient sealing in any position of the slide and allow the water to flow only in the opened part of the gate.
- L. The bottom seal shall be made of resilient EPDM set into the bottom member of the frame and shall form a flush-bottom.
- M. Seal/seat design shall be field-replaceable.

2.05 SLIDE PLATES

- A. The plate shall be of minimum thickness 1/4" extruded aluminum alloy meeting ASTM B-209 reinforced with stiffeners as required so the plate will not deflect more than 1/360th of the span of the gate under the design head. The plate shall be equipped with handles for use in raising and lowering. Handles will be stainless steel castings which shall be welded to the plate. No hand holes through the plate will be allowed. For gates wider than 24", two handles will be provided.
- B. The guides and inverts shall be of Type 304 or 316 stainless steel construction. The guides shall be designed for maximum rigidity and shall have a weight of

not less than 1.5 lbs per linear foot. The guides shall be designed to embed in or mount to the face of the concrete and shall be provided with keyways to lock them into the concrete. The invert of the frame shall be welded to the lower ends of the guides. The guides will incorporate an ultra-high molecular weight double winged polymer strip on both the upstream and downstream side of the plate.

The polymer strips will be held in dovetailed grooves.

- C. Specially extruded resilient seals shall be mounted on the frame to provide flush-bottom closure.

2.06 STEMS AND COUPLINGS

- A. Stems shall be stainless steel. Stem threads shall be of the cut ACME type. Stems shall be designed to transmit in compression a minimum of two times the rated output of the hoist at 40 lbs. effort on the crank or handwheel. The L/r ratio of the unsupported stem shall not exceed 200. Stem guides, where required to limit the unsupported stem length shall be Type 304L stainless steel. Guides shall be adjustable and equipped with an UHMWPE bushing.
- B. Where a hydraulic, pneumatic, or electric operator is used, the stem design force shall not be less than 1.25 times the output thrust of the hydraulic or pneumatic cylinder with a pressure equal to the maximum working pressure of the supply, or 1.25 times the output thrust of the electric motor in the stalled condition.
- C. For stems in more than one piece and with a diameter of 1-1/2 inches and larger, the different sections shall be jointed together by solid bronze couplings. A minimum 1-1/2 inch diameter stem shall be provided.
- D. The couplings shall be grooved and keyed and shall be of greater strength than the stem.

2.07 LIFTING MECHANISMS

- A. Manual operators shall be crank type unless otherwise noted. Provide gearbox for large gates based on manufacturer's recommendation.
- B. All gate with width in excess of 72-inches and/or widths greater than twice their height shall be provided with two gearboxes connected by a shaft for simultaneous operation.
- C. All bearings and gears shall be totally enclosed in a weather tight housing. The pinion shaft of crank operated mechanisms shall be constructed of stainless steel and supported by roller or needle bearings.
- D. Each manual operator shall be designed to operate the gate under the maximum specified seating and unseating heads by using a maximum effort of 40 lbs on

the crank or handwheel and shall be able to withstand, without damage, an effort of 80 lbs.

- E. The crank shall be removable and fitted with a corrosion resistant rotating handle. The maximum crank radius shall be 7.5 inches and the maximum handwheel diameter shall be 24 inches.
- F. Gates with non-rising stems shall be equipped with a 2-inch AWWA nut at floor level unless noted otherwise. Provide stainless steel floor box with sealed cover with each nut. Provide gearbox for large gates based on manufacturer's recommendation.
- G. Lifting mechanisms shall be mounted on a fabricated steel or cast iron standard pedestal or off-set pedestal or yoke mounted, as required on the Drawings.
- H. The direction of rotation to open the gate shall be indicated on the lift mechanism.
- I. Gates specified to have electric actuators shall be equipped with a clutch to quickly uncouple the electrical actuator. Gates shall have a manual operator, crank type

2.08 STEM COVERS

- A. Rising stem gates shall be provided with clear polycarbonate stem covers (ASTM D3935) to provide visual indication of gate position, permit inspection of the stem threads and to protect the stem from contamination. Vent holes shall be provided to prevent condensation.
- B. The cover shall be of sufficient diameter and length to permit full travel of the threaded stem without obstruction. The top of the stem cover shall be closed with a plastic cap. The stem cover shall be easily field mounted. Provide a clear mylar position indicating tape. The tape shall be field applied to the stem cover after the gate has been installed and positioned.

2.09 PEDESTALS

- A. Shall be constructed of stainless steel. Aluminum pedestals are not acceptable.
- B. The pedestal height shall be such that the handwheel or pinion shaft on the crank-operated gearbox is located approximately 36 in above the operating floor.
- C. Wall brackets shall be used to support floor stands where shown on the Drawings and shall be constructed of stainless steel.
- D. Wall brackets shall be reinforced to withstand in compression at least two times the rated output of the operator with a 40 lb. effort on the crank or handwheel.

- E. The design and detail of the brackets and anchor bolts shall be provided by the gate manufacturer and shall be approved by the Engineer. The gate manufacturer shall supply the bracket, anchor bolts and accessories as part of the gate assembly

2.10 ANCHOR BOLTS

- A. Contractor shall provide anchor bolts of ample size and strength required to securely anchor each item of equipment in accordance with equipment manufacturer's requirements. Bolts, washers and hex nuts shall be AISI Type 304 stainless steel unless noted otherwise. Anchor bolts shall be adhesive-type stainless steel.
- B. Anchor bolts shall be set by the Contractor using templates provided by the equipment manufacturer. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations.
- B. Systems to be installed complete with all necessary connections and fittings.
- C. Contractor responsible for adequate amount of appurtenances required to provide a complete and functional system.
- D. Layout and install supports in accordance with manufacturer's instructions and anchor setting plan.

3.02 FIELD QUALITY CONTROL

- A. Manufacturers Field Service
 - 1. Provide services of an Experienced, Competent and Authorized Representative of Manufacturer for a minimum of eight (8) hours:
 - a. Inspect equipment covered by these Specifications.
 - b. Supervise any adjustments and installation checks.
 - c. Conduct start-up of equipment and perform operation checks and tests.
 - d. Reference Sections 01 45 00 and 01 75 00 for additional requirements.
 - 2. Furnish Owner and Engineer with a written report prepared by equipment supplier certifying that equipment:
 - a. Has been properly installed.
 - b. Is in accurate alignment.
 - c. Is free from an undue stress imposed by connecting piping, anchor bolts, etc.

- d. Has been operated through at least two complete open/close cycles.
 - e. Checked for leakage.
- 3. After installation, all gates shall be field tested in the presence of the Engineer and Owner to ensure that all items of equipment are in full compliance with this Section. Each gate shall be cycled to confirm that they operate without binding, scraping, or distorting. The effort to open and close manual operators shall be measured, and shall not exceed the maximum operating effort specified above. Electric motor actuators shall function smoothly and without interruption. Each gate shall be water tested by the Contractor, at the discretion of the Engineer and Owner, to confirm that leakage does not exceed the specified allowable leakage.

3.03 COMMISSIONING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.

3.04 CLASSROOM AND DEMONSTRATION TRAINING

- A. Manufacturer shall provide four (4) hours of classroom and demonstration operator training by a qualified representative of the manufacturer for Owner's personnel after system is operational. Training will occur on a schedule convenient to the Owner. Training will not take place while manufacturer's representative is at the job site during start up or prefunctional testing.

3.05 SPARE PARTS

- A. Furnish lubricating materials to allow for one year of operation. Lubricating materials shall be as recommended by the manufacturer.
- B. Furnish the following spare parts:
 - 1. One (1) spare 7.5" radius crank handle or handwheel compatible per gate for gates supplied.

END OF SECTION 40 27 30

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SECTION 40 27 60
PROCESS IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. Pipe markers.
2. Equipment, valve, gate, flow meter, and instrument markers.
3. The methods and materials specified herein apply to all piping and equipment in Divisions 40 and Division 46.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures
2. Section 09 90 02 - High Performance Painting and Coating
3. Division 46 – Water and Wastewater Equipment.
4. Division 23 – Heating, Ventilating, and Air-Conditioning (HVAC)
5. Division 26 – Electrical

1.02 REFERENCES

A. Reference Standards include:

1. Ten States Standards for Wastewater - 54.5 Piping Color Recommendations.

B. ANSI A13.1 - 1981: Schemes for Identification of Piping Systems.

1.03 SUBMITTALS

A. Submit color schedule under provisions of Section 01 33 00.

B. Submit location drawing and shop drawings on markers under provisions of Section 01 33 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Acceptable Pipe Marker Manufacturers:

1. W.H. Brady Co.
2. Seton Nameplate Corp.
3. Chemelex Div., Raychem Corp.
4. Koibi Industries, Inc.
5. John P. Nissen Jr. Co.

6. Zippertubing Co.
7. Emedco.

2.02 PIPE MARKERS

- A. All pipes, regardless of material, shall receive pipe markers.
- B. Process piping containing corrosive or hazardous chemicals shall have labels every ten feet with a minimum of two labels in each room, closet, or pipe-chase.
- C. Pipe Size $\frac{3}{4}$ inch through 6 inch Diameter:

1. One piece, snap around and completely encircle pipe with substantial overlap and permanent tension to grip pipe firmly without adhesives.
2. Provide with flow arrows.
3. Clearly indicate pipe size and service code on line.
 - a. Example: 4-WAS
4. Size of Legend Letters and Numbers:

Outside Diameter of Pipe or Pipe Covering	Size of Legend Letters and Numerals
$\frac{3}{4}$ " to 1- $\frac{1}{4}$ "	$\frac{1}{2}$ "
1- $\frac{1}{2}$ " to 2"	$\frac{3}{4}$ "
2- $\frac{1}{2}$ " to 6"	1- $\frac{1}{4}$ "

5. Comply with ANSI Standard A13.1 – 1996.
6. Material: Pre-formed acrylic/vinyl plastic.
7. Working printed in a "repeat and reverse" pattern.
8. Adhesive markers will not be allowed.

- D. Pipe Size 8 inch Diameter and Larger:

1. After process pipe has been finish coated per Section 09 90 02 - High Performance Painting and Coating, apply pipe name with painted on stenciling.
2. Clearly indicate pipe size and service code in stencil.
 - a. Example: 8-RAS
3. Provide each label with flow arrow adjacent to text.
4. Size of Legend Letters and Numbers:

Outside Diameter of Pipe or Pipe Covering	Size of Legend Letters and Numerals
8" to 10"	2"
Over 10"	3"

- E. Paint on each pipe at 120 or 180 degree intervals based on pipe size and location. Arrange so labeling of similar pipe runs are spaced and oriented the same. Coordinate label placement with Owner and Engineer.
- F. Stack stencil wording were applicable. Center flow arrow between words in vertical direction.
- G. Coordinate and maintain consistent spacing and stencil locations from filter to filter, between flanges, and within plant walls and penetrations for neat appearance.
- H. Stencil paint color to be selected by Engineer to provide required contrast between process pipe coating and stencil identification.

2.03 CONTROL DEVICE MARKERS

- A. After process pipe, equipment, valves, flow meters, and other appurtenances have been finish coated per Section 09 90 02 - High Performance Painting and Coating, apply metal nametag for all pieces of equipment, valves, gates, flow meters, and instruments.
 - 1. Metal tag shall include the full tag including building following the examples below and the schedules provided in the drawings:
 - a. PTB-MS1
 - b. PTB-GP1-PV1
 - c. PTB-GP1-FE1
- B. Material: Stainless Steel.
- C. Size: 3 inch diameter, round shape, 0.025-inch thickness
- D. Provide with holes for hanging.
- E. Stamp tag with appropriate name or number. See the equipment schedule, valve schedule, and instrument schedule in the construction drawings for equipment, valves, flow meters, gates, and instruments.
- F. Provide metal tags as required. Contractor shall verify number of valves, flow meters, equipment, and instruments requiring tags.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. All process piping 1/2" or greater shall be scheduled for painting and identification. Marker colors shall be yellow with black lettering unless indicated otherwise.
- B. Pipe Markers:

1. Install on all piping systems at the following locations or at Engineer's direction:
 - a. Adjacent to each valve.
 - b. Each branch and riser at take-off.
 - c. At each pipe passage through wall or floor.
 - d. At not more than 20 feet spacing on straight pipe runs.
 - e. At each change in direction.
2. Provide number and copy indicated in schedule below.

C. Painting:

1. Finish painting of all materials and equipment shall be the responsibility of the General Contractor, and shall be as described in Section 09 90 02 - High Performance Painting and Coating.
2. Colors: As coordinated with Engineer.
 - a. Owner and Engineer reserve the right to change color selections during shop drawing review based on available color chart options. Where applicable, Contractor shall field verify and match existing pipe colors.
3. All PVC carrier piping shall be painted according to chemical tubing carried.
4. Provide 2-inch bands at 30 inch intervals where banding is required. Provide 2-inch width with straight edges and neat appearance. Contractor also has the option to use colored electric tape for identification banding in lieu of painting bands.

D. Control Device Markers

1. Attach with a corrosion resistant material.
2. Attach at all process valves, flow meters, equipment, pressure transducers, and ultrasonic level transducers.

END OF SECTION 40 27 60

SECTION 40 42 13
PROCESS PIPING INSULATION AND HEAT TRACING

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes furnishing and installation of the following, as indicated, in accordance with the provision of the Contract Documents:

1. Piping insulation and heat tracing around exposed process piping.

B. Related section include:

1. Section 01 11 13 - Work Covered by Contract Documents
2. Section 01 11 16 - Work by Owner
3. Section 01 33 00 - Submittal Procedures.
4. Section 01 45 00 - Quality Control.
5. Section 01 61 00 - Common Product Requirements.
6. Section 09 90 02 - High Performance Painting and Coating.
7. Division 26 - Electrical
8. Section 40 27 05 - Process Piping Support Systems.
9. Section 40 27 10 - Process Piping Specialties.

1.02 REFERENCES

A. Reference Standards include:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
 - a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
 - b. C165 Standard Test Method for Measuring Compressive Properties of Thermal Insulation.
 - c. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
 - d. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - e. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - f. C547, Standard Specification for Mineral Fiber Pipe Insulation.
 - g. C552, Specification for Cellular Glass Thermal Insulation.

- h. C585, Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
- i. C1136, Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
- j. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
- k. E96, Standard Test Methods for Water Vapor Transmission of Materials.
- 3. International Code Council (ICC) International Energy Conservation Code (IECC).
- 4. Manufacturers Standardization Society (MSS): SP-69, Pipe Hangers and Supports.
- 5. Underwriters Laboratories Inc. (UL).

1.03 QUALITY ASSURANCE

- A. Materials furnished under this Specification shall be standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.
- B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.
- C. UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Product description, include list of materials, thickness for each service scheduled, and locations.
 - 2. Insulation and heat load calculations
- B. Informational Submittals:
 - 1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
 - 2. Manufacturer's installation instructions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Stamp or Label:

1. Every package or standard container of insulation, jackets, cements, adhesives and coatings delivered to Site shall have manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation packages and containers shall be marked "asbestos-free."

PART 2 - PRODUCTS

2.01 GENERAL

- A. Insulation exterior shall be cleanable, grease-resistant, nonflaking, and nonpeeling.
- B. Insulation shall conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.
- C. Insulation for fittings, flanges, and valves shall be premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.
- D. Fire Resistance:
 1. Insulation, adhesives, vapor barrier materials and other accessories, except as specified herein, shall be noncombustible.
 2. Use no fugitive or corrosive treatments to impart flame resistance.
 3. Flame proofing treatments subject to deterioration due to effects of moisture or high humidity are not acceptable.
 4. Materials including facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with NFPA 255 methods.
 5. Materials exempt from fire-resistant rating:
 - a. Nylon anchors.
 - b. Treated wood inserts.
 6. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
 - a. Polyurethane insulation.
 - b. PVC casing.
 - c. Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

- A. Type 1—Elastomeric:
 1. Material: Flexible elastomeric pipe insulation, closed-cell structure in accordance with ASTM C534.
 2. Temperature Rating: Minus 40 degrees F to 220 degrees F.
 3. Nominal Density: 6 pcf.

4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.25 Btu-in/hr-square foot degrees F at 75 degrees F per ASTM C177 or ASTM C518.
5. Minimum water vapor transmission of 0.08 perm-inch per ASTM E96, Procedure A.
6. Joints: Manufacturer's adhesive.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
 - a. Rubatex; Insul-Tube 180 or Insul-Sheet 1800.
 - b. Armacell; AP Armaflex.

B. Type 2—Fiberglass:

1. Material: UL rated, preformed, sectional bonded fiberglass per
2. ASTM C585 with factory applied, Kraft paper with aluminum foil vapor barrier jacket with pressure-sensitive, self-sealing lap.
3. Insulation Temperature Rating: Zero to 850 degrees F.
4. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.23 Btu-in/hr-square foot degrees F at 75 degrees F.
5. Jacketing per ASTM C1136 with minimum water vapor transmission for jacket of 0.02 perm-inch per ASTM E96. Furnish with no jacket if field finish system specified.
6. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
7. Flame Spread Rating: Less than 25 per ASTM E84.
8. Smoke Developed Index: Less than 50 per ASTM E84.
9. Manufacturers and Products:
 - a. Owens Corning Fiberglass; ASJ/SSL-11.
 - b. John Manville; Micro-Lok with Jacket.

C. Type 3—Foam glass:

1. Material: Cellular glass per ASTM C552.
2. Nominal Density: 7.5 pcf.
3. Compressive Strength: 90 psi per ASTM C165.
4. Temperature Rating: Minus 290 to 900 degrees F.
5. Conductivity in accordance with ASHRAE 90.1 and maximum numerical value of 0.29 Btu-in/hr-square foot degrees F.
6. Minimum water vapor transmission for insulation of 0.00 perm-inch per ASTM E96.
7. Joints: Matching pressure-sensitive butt strips for sealing circumferential joints.
8. Flame Spread Rating: 0 per ASTM E84.
9. Smoke Developed Index: 0 per ASTM E84.

10. Follow manufacturer's recommendation, based upon temperature of piping to be insulated.
11. Manufacturer and Product: Pittsburgh Corning; Foamglas.

2.03 FITTING INSULATION

- A. Type 1: Same as pipe.
- B. Type 2:
 1. Wired in-place premolded insulation or mitered segments, or soft fiberglass insulation inserts covered with premolded 20-mil minimum thickness PVC fitting covers.
 2. Manufacturers:
 - a. Manville Zeston.
 - b. Speedline.
 - c. Proto.
 - d. Ceel-Co.
- C. Type 3: Same as pipe.

2.04 ROOF DRAIN AND OVERFLOW DRAIN SUMP INSULATION

- A. Type 1: 1 inch thick.

2.05 INSULATION AT PIPE HANGERS AND SUPPORTS

- A. Refer to Section 40 27 05 - Process Piping Support Systems .
- B. Copper, Ductile Iron, and Nonmetallic Pipe: High density inserts, thickness equal to adjoining insulation, of Type 3 or other rigid insulation or manufactured pre-insulated pipe hangers and insulation shields per MSS SP-69, Table 5 at support locations. Extend inserts beyond shields.
- C. Steel Pipe: Insulation saddles or high-density inserts, thickness equal to adjoining insulation, of Type 3 or other rigid insulation or manufactured pre-insulated pipe hangers and insulation shields per MSS SP-69, Table 5 at support locations. Extend inserts beyond shields.

2.06 HEAT TRACE

- A. Provide heat tracing conduit, electric tracing cable, power connection kits, terminal end seal kits, and specified thermostatic controllers. Contractor shall install heat tracing and controllers in accordance with manufacturer's recommendations. Contractor shall coordinate installation with appropriate subcontractors.
- B. Heat tracing system shall be constant wattage, sized to maintain pre-insulated piping system at 60 degrees F in ambient soil or air temperature of -20 degrees

F. System design shall be for the specific site soil conditions, overall pipe lengths, and pipe sizes.

C. Heat Tracing Cable

1. Provide CSA-approved cable, certified for use in wet applications.
2. Cable shall provide constant wattage of 2 watts per foot minimum with a maximum circuit length of 450 feet.
3. Cable shall be parallel resistance type heating strip which uses a thermally stable nichrome heating wire.
4. Provide smooth overjackets and color-coded cable.

D. Thermostat Controller

1. Provide sufficient controllers for heat traced pipe as recommended by pipe manufacturer.
2. Controllers shall have ground fault detection circuitry, use 120 VAC power, and have NEMA 4 painted steel enclosures.
3. Controllers shall be factory set with low level temperature of 60 degrees F, and high level temperature of 140 degrees F.

2.07 INSULATION FINISH SYSTEMS

A. Type F1—PVC:

1. Polyvinyl chloride (PVC) jacketing, minimum 20 mils indoors and 30 mils outdoors, white, for straight run piping and fitting locations, temperatures to 140 degrees F.
2. Flame Spread Rating: 25 per ASTM E84.
3. Smoke Developed Index: 50 per ASTM E84.
4. Manufacturers and Products:
 - a. Knauf; Proto 1000.
 - b. Johns Manville; Zeston 2000.

B. Type F2—Paint:

1. Type 1 Insulation:
 - a. Acrylic latex paint, white, and suitable for outdoor use.
 - 1) Manufacturers and Products:
 - a) Armstrong; WB Armaflex finish.
 - b) Rubatex; 374, white finish.
2. Type 2 Insulation: System 9 per Section 09 90 02 - High Performance Painting and Coating.

C. Type F3—Aluminum:

1. Aluminum Roll Jacketing: For straight run piping, wrought aluminum Alloy 3003, 5005, 1100, or 3105 to ASTM B209 with H-14 temper, minimum 0.016 inch thickness, with smooth mill finish.
 2. Vapor Barrier: Provide factory applied vapor barrier, consisting of 40-pound craft paper with 1-mil thick low density polyethylene film, heat and pressure bonded to inner surface of aluminum jacketing.
 3. Fitting Covers: Material as for aluminum roll jacketing, premolded, one or two piece covers, which includes elbows, tee/valves, end caps, mechanical line couplings, and specialty fittings.
 4. Manufacturers:
 - a. RPR Products; Insul-Mate.
- D. Type F4—Foam glass Jacketing:
1. Type 3 Insulation—Buried and Up to 1 Foot Above Grade: Jacket system to Pittsburgh Corning-Pittwrap SS, 70-mil bituminous resin with woven, glass fabric, aluminum foil layer, and plastic film coating, heat- sealed at overlap.
 2. Type 3 Insulation—Greater than 1 Foot Above Grade: Jacket system to Pittsburgh Corning-Pittwrap CW30, 30-mil modified bituminous membrane with manual jacket pressure seals.

PART 3 - EXECUTION

3.01 APPLICATION

- A. General:
1. Insulate valve bodies, flanges, and pipe couplings.
 2. Insulate and vapor seal hangers, supports, anchors, and other piping appurtenances that are secured directly to cold surfaces.
 3. Do not insulate flexible pipe couplings and expansion joints.
 4. Service and Insulation Thickness: Insulation shall be provided to the required R-value.
 5. All above ground liquid piping shall be heat traced and insulated, minimum type 3 insulation with Type F3 jacket.

3.02 INSTALLATION

- A. General:
1. Install in accordance with manufacturer's instructions and as specified herein, and in accordance with recognized industry practices.
 2. Install insulation after piping system has been pressure tested and leaks corrected.
 3. Apply insulation over clean dry surfaces.
 4. Do not allow insulation to cover nameplates or code inspection stamps.

5. Run insulation or insulation inserts continuously through pipe hangers and supports, wall openings, ceiling openings, and pipe sleeves, unless otherwise shown.
 6. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.
 7. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.
 8. Personnel Protection: Install on pipes from floor to 8 feet high. Install on pipes within 4 feet of platforms and to 8 feet high above platforms.
- B. Connection to Existing Piping: Cut back existing insulation to remove portion damaged by piping revisions. Install new insulation.
- C. Cold Surfaces: Provide continuous vapor seal on insulation on cold surfaces where vapor barrier jackets are used.
- D. Placement:
1. Slip insulation on pipe or tubing before assembly when practical to avoid longitudinal seams.
 2. Insulate valves and fittings with sleeved or cut pieces of same material.
 3. Seal and tape joints.
 4. Do allow pipe, pipe insulation, pipe jacketing to rest on ground.
- E. Insulation at Hangers and Supports: Insulation or insulation inserts to be continuous through hanger or support.
- F. Heat Traced Piping: Apply insulation after heat-tracing work is completed and inspected.
- G. Roof Drains: Insulate vertical drops from roof drain to horizontal pipe, exposed and concealed horizontal piping, and 2 feet down on vertical risers from horizontal pipe.
- H. Roof and Overflow Drain Sumps: Insulate underside.
- I. Vapor Barrier:
1. Provide continuous vapor barrier at joints between rigid insulation and pipe insulation.
 2. Install vapor barrier jackets with pipe hangers and supports outside jacket.
 3. Do not use staples and screws to secure vapor sealed system components.
- J. Aluminum Jacket:

1. Use continuous friction type joint to hold jacket in place, providing positive weatherproof seal over entire length of jacket.
2. Secure circumferential joints with preformed snap straps containing weatherproof sealant.
3. On exterior piping, apply coating over insulation and vapor barrier to prevent damage when aluminum fitting covers are installed.
4. Do not use screws or rivets to fasten the fitting covers.
5. Install removable prefabricated aluminum covers on exterior flanges and unions.
6. Caulk and seal exterior joints to make watertight.

3.03 FIELD FINISHING

- A. Apply coating of insulating cement where needed to obtain smooth and continuous appearance.
- B. Where pipe labels or banding are specified for a piping system they shall be applied to the finished insulation and not to the pipe.
- C. Painting Piping Insulation (Exposed to View):
 1. Metal or PVC jacketing does not require painting.
 - a. Paint piping prior to heat tracing and insulating. Paint pipe and insulation in accordance with Section 09 90 02 - High Performance Painting and Coating.

3.04 SUPPLEMENTS

- A. The supplement listed below, following "End of Section," is a part of this specification:
 1. Service and Insulation Thickness table.

END OF SECTION 40 42 13

Service and Insulation Thickness									
Service Type	Pipe Legend	Location	Thickness	Fluid Temperature (Degrees F)	Insulation	Finish Systems			
						Concealed From View	Indoors Exposed	Outdoors	Buried
Effluent Aeration Air Service / Process Air Service	EAB / Process Air	Effluent Aeration Blowers / Factory Built Wastewater Equipment	0.5-Inch Minimum, ASHRAE 90.1 Or IECC (Whichever Results in Thickest Insulation)	50 to 160	Type 3	Na	N/A	F3	F3
Wastewater	Sewer	Factory Built Wastewater Equipment	2-Inch Minimum, ASHRAE 90.1 Or IECC (Whichever Results in Thickest Insulation)	-30 to 100	Type 3	NA	N/A	F3	F3
Sludge / Scum / Backwash	SLD / SCM / EBW	Factory Built Wastewater Equipment	2-Inch Minimum, ASHRAE 90.1 Or IECC (Whichever Results in Thickest Insulation)	-30 to 100	Type 3	NA	N/A	F3	F3

SECTION 40 42 80
PROCESS PIPING LEAKAGE TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Performing of the following, as indicated, in accordance with the provision of the Contract Documents:
 - a. Leakage testing of process piping.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures .
2. Section 01 45 00 - Quality Control .
3. Section 01 61 00 - Common Product Requirements .
4. Section 01 75 00 - Starting and Adjusting .
5. Section 01 77 00 - Closeout Procedures .
6. Section 01 78 23 - Operation and Maintenance Data .
7. Section 40 27 00 - Process Piping - General.
8. Section 40 27 05 - Process Piping Support Systems .
9. Section 40 27 20 - Process Valves .

1.02 SUBMITTALS

A. Informational Submittals:

1. Testing Plan: Submit prior to testing and include at least the information that follows.
 - a. Testing dates.
 - b. Piping systems and section(s) to be tested.
 - c. Test type.
 - d. Method of isolation.
 - e. Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified test report.

1.03 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Chlorine Institute (2001 L Street N.W., Washington D.C. 28036): Pamphlet 6, Piping Systems for Dry Chlorine.
2. AWWA C600-99.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Notify Engineer in writing 5 days in advance of testing. Perform testing in presence of Engineer.
- B. Hydrostatically test in accordance with AWWA C600-99 and AWWA C605.
- C. Pressure Piping:
 - 1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
 - 2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
 - 3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
 - 4. Chemical Piping: Test, dry, and clean in accordance with requirements of Chlorine Institute Pamphlet 6.
 - 5. New Piping Connected to Existing Piping:
 - a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Engineer.
 - b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Engineer.
 - 6. Items that do not require testing include: Piping between wet wells and wet well isolation valves, Equipment seal drains, tank overflows to atmospheric vented drains and tank atmospheric vents.
 - 7. Test Pressure: As specified in specifications or as specified by equipment manufacturer.
- D. Test section may be filled with water and allowed to stand under low pressure prior to testing.
- E. Gravity Piping:
 - 1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
 - 2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Engineer.
 - 3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

- A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.
- B. Exposed Piping:
 - 1. Perform testing on installed piping prior to application of insulation.
 - 2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
 - 3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
 - 4. Maintain hydrostatic test pressure continuously for two (2) hours, minimum, and for such additional time as necessary to conduct examinations for leakage.
 - 5. Examine joints and connections for leakage.
 - 6. Correct visible leakage and retest as specified.
 - 7. Empty pipe of water prior to final cleaning or disinfection.

3.03 HYDROSTATIC TEST FOR GRAVITY PIPING

- A. Testing Equipment Accuracy: Plus or minus 1/2 -gallon water leakage under specified conditions.
- B. Maximum Allowable Leakage: 0.16 gallons per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.
- C. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.
- D. Exfiltration Test:
 - 1. Hydrostatic Head:
 - a. At least 6 feet above maximum estimated groundwater level in section being tested.
 - b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
 - 2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.
- E. Infiltration Test:
 - 1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

- F. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.
- G. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.04 PNEUMATIC TEST FOR PRESSURE PIPING

- A. Do not perform on:
 - 1. PVC or CPVC pipe.
 - 2. Piping larger than 18 inches.
 - 3. Buried and other non-exposed piping.
- B. Fluid: Oil-free, dry air.
- C. Procedure:
 - 1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
 - 2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
 - 3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
 - 4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
 - 5. Correct visible leakage and retest as specified.
- D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.
- E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.05 PNEUMATIC TEST FOR GRAVITY PIPING

- A. Equipment:
 - 1. Calibrate gauges with standardized test gauge provided by Contractor at start of each testing day. Engineer will witness calibration.
 - 2. Install gauges, air piping manifolds, and valves at ground surface.
 - 3. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.

4. Restrain plugs used to close sewer lines to prevent blowoff.

B. Procedure:

1. Require that no person enter manhole where pipe is under pressure.
2. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average back pressure of groundwater submerging pipe.
3. Allow 2 minutes minimum for air temperature to stabilize.

C. Allowable Leakage: Test section will be considered defective when time required for pressure to decrease from 3.5 to 2.5 psi greater than average back pressure of groundwater submerging pipe is less than that computed utilizing values from following table:

TABLE 1*

A	B	C	D	E	F
Pipe Diameter (Inches)	Time per Foot up to Length in Col C (Seconds)	Test Length (Feet)	Test Time for any Length Between Col C & E (Min: Sec)	Length at Which Time in Col F Applies (Feet)	Time per Foot for Total Length (Seconds)
4	0.18	636	1:54	1,114	0.10
6	0.40	424	2:50	743	0.23
8	0.71	318	3:47	557	0.41
10	1.11	255	4:43	446	0.63
12	1.60	212	5:40	371	0.91
15	2.50	170	7:05	297	1.42
18	3.62	141	8:30	248	2.06
21	4.92	121	9:55	212	2.81
24	6.42	106	11:20	187	3.67

EXAMPLE: 15-inch diameter pipe:

For 150 feet, $T = 2.50 \text{ sec (Col B)} \times 150 \text{ ft} = 375 \text{ sec} = 6:15$

For 250 feet, $T = 7:05 \text{ (Col D)}$

For 500 feet, $T = 1.42 \text{ sec (Col F)} \times 500 \text{ ft} = 710 \text{ sec} = 11:50$

*Based on 0.003 cfm per square foot with a minimum significant loss of 2 cfm and a maximum loss of 3.5 cfm.

D. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

E. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.06 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.
5. Remarks, including:
 - a. Leaks (type, location).
 - b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Owner's Representative to represent that test has been satisfactorily completed.

END OF SECTION 40 42 80

SECTION 40 53 13
OEM CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

Note, The OEM system manufacturers as specified in other sections shall provide a control panel which meets the requirements of this specification.

A. Description

1. Complete PLC based control system with Supervisory Control and Data Acquisition (SCADA) functions.
2. This section is intended to cover all work necessary for the procurement of the wastewater system facility process control and instrumentation equipment. This includes all specified and required equipment installed and place into acceptable operation as herein described.

B. Responsibility and Coordination

1. It shall be the responsibility of the OEM equipment supplier to provide a complete, fully operating and acceptable system. Drawings and Specification are intended to describe a complete installation for the purpose specified and to detail the scope of work for the OEM equipment supplier.
2. The OEM equipment supplier shall be responsible for all detail that may be necessary to properly provide, and place in operation, the complete installation. The OEM equipment supplier shall assume full responsibility for additional cost that may result from unauthorized deviation from the project documents.

C. Related sections include, but are not limited to:

1. Section 40 63 43 - Programmable Logic Controllers.
2. Instrumentation:
 - a. Section 40 72 00 - Level Measurement
 - b. Section 40 75 00 - Process Liquid Analytical Measurement

D. Work Items Specified Under This Section

1. OEM Control Panel Requirements.
2. General Control System Scope.
3. System Control Panels.
4. Control Panel Components.
5. OEM System Manufacturer Required Services.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The system controls, alarms, and telemetry shall be constructed as shown on drawings and herein described.
- B. Any deviations from the Goods and Services Proposal Price Request shall be submitted in writing for approval to the Engineer seven (7) days before proposal date and be denoted in the submitted proposal.

2.02 PROCESS CONTROL PANEL

- A. The control panels shall include the following
 1. Enclosure with back panel and mounting provisions.
 2. Interior light activated by door switch provided for each door of the enclosure.
 3. Transient and surge suppression for power and control input/output.
 4. Linear regulated DC power supplies. Power supplies shall be UL listed for use in type 508 or 698 Industrial Control Panels as required: AC power input fusing AC power transient protection current Limiting AC "power on" indication.
 5. Separate terminal blocks for inputs and outputs.
 6. GFCI receptacle outlet (120V).
 7. Programmable logic controller with I/O modules as required.
 8. Lockable door handle.
 9. Inner door pocket for storing wiring diagrams.
 10. 18"x18" fold up programming shelf on all free standing enclosures.
 11. See E drawings for door mounted devices and associated labeling.
 12. Enclosure size shall be selected based off of equipment as shown in the E Drawings and within this specification. Any enclosure sizing shown within the drawings are to be used as a minimum size. It is up to the control system manufacturer to increase the size of any enclosure to ensure all equipment fits with reasonable space remaining.
- B. Enclosure Schedule:
 1. Control Panel Enclosure(s) shall be furnished and installed for the following application(s):
 - a. NEMA Type 12 Painted Steel
 - 1) Free Standing
 - a) As required.
 - 2) Wall Mounted
 - a) As required.
 - b. NEMA Type 4X Stainless Steel

- 1) Free Standing
 - a) As required.
- 2) Wall Mounted
 - a) As required.

C. Manufacturer/Model:

1. Hoffman
2. SCE
3. Prior Approved Equal

2.03 PROCESS CONTROL PANEL COMPONENTS

A. Main Breaker

1. Provide main breaker as required.
2. Voltage, amperage rating, and KAIC rating can be found on the one-line diagrams within the electrical drawings or in related specification section.
3. Install thru-door handle as needed where handles are installed on the front of the enclosure.
4. Manufacturer/Model:
 - a. SquareD
 - b. Prior Approved Equal

B. Transformer

1. Install in control panel as specified by manufacturer.
2. Voltage and VA rating can be found on the one-line diagrams within the electrical drawings.
3. Transformer Schedule:
 - a. Shall be furnished and installed in the following application(s):
 - 1) As required.
 - b. Refer to One-lines in Engineers Drawings for Control Panels requiring transformers.
4. Manufacturer/Model:
 - a. SquareD 9070T
 - b. Prior Approved Equal

C. Panel Heater

1. Manufactured unit with aluminum housing and integral thermostat and 0°F to 100°F adjustable range.
2. Provide quantity and size as required to meet temperature requirements specified.
3. UL labeled
4. Panel Heater Schedule:

- a. Shall be furnished and installed in the following application(s):
 - 1) Outdoor junction boxes with equipment requiring heated environments.
- b. Refer to the Control Panel Drawings and BOM within the Engineers Drawings for quantity and requirements.
- 5. Manufacturer/Model:
 - a. Hoffman DAH Series
 - b. Prior Approved Equal

D. Terminal Blocks

- 1. General Specifications:
 - a. DIN rail mounted, touch safe, modular type.
 - b. Minimum Rated Voltage: 600V RMS
 - c. Minimum Rated Current: 24 amps or higher as required per application
 - d. Connector metal body material: Copper alloy, min 85% copper with nickel or tin plating
 - e. Terminal screw material: Bronze with tin plating
 - f. Terminal Block Characteristics:
 - 1) It shall terminate wires without additional preparation: i.e. tinning of wire ends, application of ferrules, etc.
 - 2) The insulation housing shall have primary entry funnels to facilitate insertion of wires.
 - 3) The insulation housing shall prevent stray strands from shorting to adjacent terminal blocks.
 - 4) Terminal screws shall be captive in the metal body or via the insulation housing.
 - 5) Once tightened the terminal screws shall be locked in place to prevent loosening due to shock and vibration.
 - 6) The terminal block shall be useable with accessories such as center or insertion bridges, test sockets, separating plates, end covers, etc. The accessories used shall also be touch safe.
 - 7) For wire identification, the terminal block shall provide space for marking with pre-marked labels. Handwritten labels shall not be allowed.
 - g. Manufacturer/Model:
 - 1) Allen Bradley 1492-J4
 - 2) Phoenix Contact UT 4
 - 3) ABB

- 4) Weidmuller
- 5) Prior Approved Equal
- 6) No Exceptions

E. Miniature Circuit Breakers

- 1. General Specifications:
 - a. UL489 Branch Protection
 - b. Trip Curves
 - 1) C Trip Curve: Low/Medium Inrush Applications
 - 2) D Trip Curve: High Inrush Applications (Motors)
 - c. SCCR (Minimum): 10kAIC
 - d. Breaker Status Indicator
 - e. Utilize 1-pole, 2-pole, and 3-pole breakers within the control panels as indicated below and as specifically indicated on the E Drawings
 - f. Miniature Breaker Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) 1-Pole
 - (1) Incoming Power Feed
 - (2) Internal Panel Components
 - (3) Electric Actuated Valves
 - (4) Chemical Metering Pumps and Equipment
 - (5) Telecommunications UPS Powered Receptacle
 - b) 2-Pole
 - (1) Incoming Power Feed
 - c) 3-Pole
 - (1) Incoming Power Feed

F. Fused Terminals

- 1. General Specifications:
 - a. DIN rail mounted, touch safe, modular type
 - b. Minimum Rated Voltage: 250V RMS
 - c. Rated Current: As required per application
 - d. Physical Dimensions: ¼" x 1 ¼" Standard Fuses
 - e. Blown fuse indicator light
 - f. Manufacturer/Model:
 - 1) Allen Bradley
 - 2) Phoenix Contact UT 6-HESILA
 - 3) Weidmuller
 - 4) Prior Approved Equal

G. Surge Suppressor

1. 480VAC 3 Phase Power
 - a. General Specifications:
 - 1) Installed in Control Panels supplied with 480VAC 3 Phase power.
 - 2) Power leads shall be as short as possible to the incoming service lines.
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) For any circuits running outside.
2. 120VAC Power
 - a. General Specifications:
 - 1) 120 VAC In-Line Device
 - 2) Max Continuous Voltage: 150 V
 - 3) Max Continuous Current: 25 A
 - 4) Measured Limiting Voltage: 760 V
 - 5) Nominal Discharge Current: 3 kA
 - 6) Response Time: < 25ns
 - 7) Connection Type: Screw
 - 8) Mounting: DIN Rail
 - 9) Style: Plug w/ Base
 - 10) Dry Contact Status Indicator
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) On any control panel being supplied with 120VAC as power.
 - c. Manufacturer/Model:
 - 1) Phoenix Contact - Plugtrab PLT-SEC-T3-120-FM-UT
 - 2) Critec Equal
 - 3) Prior Approved Equal
3. 120VAC Digital I/O
 - a. General Specifications:
 - 1) Max Continuous Voltage: 150 V

- 2) Max Continuous Current: 10 A
 - 3) Nominal Discharge Current: 2.5 kA
 - 4) Response Time: < 25ns
 - 5) Connection Type: Screw
 - 6) Mounting: DIN Rail
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) On any 120VAC digital I/O signal that goes outside of a building or control panel underground.
 - c. Manufacturer/Model:
 - 1) Phoenix Contact - Termitrab TTC-6-MOV-C-120AC-UT-I
 - 2) Prior Approved Equal
4. 24VDC Digital I/O
- a. General Specifications:
 - 1) Max Continuous Voltage: 28 V
 - 2) Max Continuous Current: 300 mA
 - 3) Nominal Discharge Current: 10 kA
 - 4) Response Time: < 1ns
 - 5) Connection Type: Screw
 - 6) Mounting: DIN Rail
 - 7) Style: Plug w/ Direct Grounding Base
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) On any 24VDC digital I/O signal that goes outside of a building or control panel underground.
 - c. Manufacturer/Model:
 - 1) Phoenix Contact - TermiTrab TTC-6P-2x1-24DC-UT-I
 - 2) Prior Approved Equal
5. VDC Analog I/O
- a. General Specifications:
 - 1) Max Continuous Voltage: 28 V
 - 2) Max Continuous Current: 450 mA

- 3) Nominal Discharge Current: 10 kA
- 4) Response Time: < 1ns
- 5) Connection Type: Screw
- 6) Mounting: DIN Rail
- 7) Style: Plug w/ Direct Grounding Base
- b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) On any analog I/O signal that goes outside of a building underground.
- c. Manufacturer/Model:
 - 1) Phoenix Contact - TermiTrab TTC-6P-1x2-24DC-UT-I
 - 2) Prior Approved Equal

H. Intrinsically Safe Barriers

- 1. VDC Isolators
 - a. General Specifications:
 - 1) Power Input Voltage: 24VDC
 - 2) Maximum Input Voltage: 27.2VDC
 - 3) Maximum Input Current: 50mA
 - 4) Operating Temperature: -20°C to +60°C
 - 5) Two-Channel with line fault detection and phase reversal
 - 6) Two relays with changeover contacts
 - 7) Din rail mounted
 - 8) UL labeled unit suitable for using non rated devices in NEC Class 1, Division 1 Group D explosive area
 - 9) Standards: NAMUR/DIN 19234
 - b. Intrinsically Safe Barrier Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) Each Analog or Digital signal within a C1D1 rated control panel or from a C1D1 location.
 - b) Each individual lift station float switch or flood switch circuit
 - c) Each lift station submersible level transmitter
 - c. Manufacturer/Model:

- 1) Eaton MTL7787+
- 2) Prior Approved Equal

I. DC Power Supply

1. Linear regulated DC power supplies.
2. Power supplies shall be U.L. listed for the use in type 508 or 698 Industrial Control Panels as required and abide to the following requirements:
 - a. 120 VAC power input.
 - b. Fusing (circuit protection) on AC power.
 - c. Transient protection.
 - d. Current Limiting.
 - e. AC "power on" indication.
 - f. DIN rail mountable.
3. Power supplies shall be sized appropriately to handle the full load connected to them.
 - a. Provide an additional 50% spare capacity.
 - b. Power calculations showing the required load with additional spare capacity shall be provided during the submittal phase.
4. Provide DC power redundancy modules where required within the electrical drawings and as indicated within these specifications.
5. Manufacturer/Model:
 - a. Allen-Bradley
 - 1) 1606-XLE Essential Series (24VDC)
 - b. Phoenix Contact
 - 1) QUINT4-PS Series (24VDC)
 - c. Prior Approved Equal

J. Control Relays

1. General Specifications:
 - a. Blade plug-in type with dust cover and socket.
 - b. Coil (Continuous Operation):
 - 1) Voltage (Unless Noted Otherwise): 24VDC $\pm$ 10%
 - c. Contacts:
 - 1) DPDT Minimum
 - 2) Voltage: 120VAC
 - 3) Current: 10A
 - d. Operating Time:
 - 1) Energization (Nominal): 35 milliseconds
 - 2) De-energization (Nominal): 100 milliseconds

- e. Mechanical Life: 10⁶ operations
- f. Operating Temperature: 0°C to 70°C
- 2. Manufacturer/Model:
 - a. Allen-Bradley
 - b. Phoenix Contact RIF-4-RSC-LV-120AC/3x21
 - c. Idec
 - d. Prior Approved Equal

K. Current Sensing Switches

- 1. General Specifications
 - a. Contacts: N.O. or N.C. solid-state dry contacts for output to PLC
 - b. Din-rail Mounting: Hardware Provided as Required
 - c. Construction: Split Core for ease of installing conductors
 - d. Trip Setpoint: Adjustable from 1.75-150A
 - e. Operating Temperature: -4°F to 122°F
 - f. LED Indication: Contact Status
 - g. UL/cUL Listed
 - h. Self Powered
- 2. Manufacturer/Model:
 - a. NK Technologies AS1 Series
 - b. Prior Approved Equal

L. Control Switches

- 1. Electronic Circuits:
 - a. General Specifications:
 - 1) Type (As Required):
 - a) Selector
 - b) Momentary Selector
 - c) Momentary Pushbutton
 - 2) Contacts (As Required):
 - a) Heavy Duty
 - b) Oil Tight
 - 3) Contacts:
 - a) Gold Flashed
 - b) Resistance: 0.01 Ohms
 - c) Rated Voltage: 120VAC
 - d) Rated Current: 0.5A
- 2. Control Circuits:
 - a. General Specifications:
 - 1) Type (As Required):
 - a) Selector
 - b) Momentary Selector
 - c) Momentary Pushbutton
 - 2) Contacts (As Required):

- a) Heavy Duty
 - b) Oil Tight
 - 3) Contact Rating: NEMA A-600
- 3. Manufacturer/Model:
 - a. Allen-Bradley Bulletin 800T/H
 - b. Prior Approved Equal

M. Indicator Lights

- 1. General Specifications:
 - a. Nominal Package Diameter: 30mm
 - b. Lamp Type: LED
 - 1) Lamp shall be easily replaceable
 - c. Type: Push to Test
 - d. Lens Color: As Shown on Drawings
 - e. Contacts (As Required):
 - 1) Heavy Duty
 - 2) Oil Tight
 - f. Ratings: NEMA 4
- 2. Manufacturer/Model:
 - a. Allen-Bradley Bulletin 800T/H
 - b. Prior Approved Equal
- 3. Digital Process Meter
 - a. General Specifications:
 - 1) Voltage:
 - a) 85-265VAC
 - b) 24VDC
 - 2) Signal Input:
 - a) 0-20mA
 - b) 4-20mA
 - c) 0-5VDC
 - d) ± 10 VDC
 - 3) Display: Dual Line 6-Digit
 - 4) Ratings:
 - a) NEMA 4X
 - b) IP65
 - b. Digital Process Meter Schedule:
 - 1) As required by other specifications sections.
 - c. Manufacturer/Model:
 - 1) Precision Digital PD6000
 - 2) No Exceptions

N. Programmable Logic Controllers (PLC)

1. See 40 63 43 - Programmable Logic Controllers.

O. Operator Interface Terminals (OIT)

1. General Specifications:

- a. Screen:

- 1) Size: As Indicated Below
 - 2) Type: Color TFT
 - 3) Input Type: Touch

- b. Communications: Ethernet TCP/IP – 10/100

- c. Memory:

- 1) On board memory
 - 2) USB Port for Data storage and application backup

- d. Power: 24VDC

2. Operator Interface Terminals (OIT) Schedule:

- a. Shall be furnished and installed in the following application(s):

- 1) Size: 7.0-inch
 - a) As required by other specifications sections.
 - b. Refer to the Control Panel Layouts within the Engineers Drawings for Quantity and Size.
 - c. Manufacturer/Model:
 - 1) Allen Bradley Panel View Plus 7
 - a) Standard
 - 2) Prior Approved Equal

P. Unmanaged Ethernet Switches

- a. Note, Unmanaged Ethernet Switches noted here is also to provide a reference for OEM control panels being furnished as part of Division 41 and Division 46 in addition to all system integrator provided control panels. This is an effort to set a standard of quality and continuity throughout the entire project.

2. General Specifications:

- a. Performance:

- 1) Unmanaged
 - 2) Store & Forward wire speed switching
 - 3) Automatic address learning, aging and migration.

- b. Power Input:

- 1) Input Voltage: 10-35VDC

- 2) Redundant input terminals
- c. Environmental Conditions:
 - 1) Operating Temperature: 0°C to 60°C
 - 2) Storage Temperature: -40°C to 85°C
 - 3) Humidity (Non-condensing): 5% to 95% RH
- d. Mounting: Din Rail
- 3. Unmanaged Ethernet Switch Schedule:
 - a. Shall be furnished and installed for the following applications:
 - 1) As required.
 - b. Refer to the Control Panel Layouts within the Engineers Drawings for Quantity and Details.
- 4. Manufacturer/Model:
 - a. Allen-Bradley Stratix 2000
 - b. Prior Approved Equal

Q. Managed Ethernet Switches

Note, Managed Ethernet Switches noted here is also to provide a reference for OEM control panels being furnished as part of Division 41 and Division 46 in addition to all system integrator provided control panels. This is an effort to set a standard of quality and continuity throughout the entire project.

- 1. General Specifications:
 - a. Performance:
 - 1) Managed
 - 2) Store & Forward
 - 3) Wire Speed Switching
 - 4) All IEEE 802.3 Ethernet protocols supported
 - b. Input Power Voltage: 12-48VDC
 - c. Environmental Conditions:
 - 1) Operating Temperature: -40°C to 60°C
 - 2) Storage Temperature: -40°C to 85°C
 - 3) Humidity (Non-condensing): 5% to 95% RH
 - d. Mounting: Din Rail
 - e. Software: Full Version
 - f. Ports:
 - 1) 16 RJ45 Ports:
 - a) 16 RJ45 ports - 10/100 BaseTx Copper

- b) 2 Combo ports - 10/100/1000 BaseTx Copper or Fiber Optic Uplink SFP
 - c) 2 SFP ports - 10/100 BaseTX Fiber Optic Uplink SFP
 - 2) 12 + 4 PoE RJ45 Ports:
 - a) 12 RJ45 ports - 10/100 BaseTx Copper
 - b) 4 RJ45 PoE ports - 10/100 BaseTx Copper PoE
 - c) 2 Combo ports - 10/100/1000 BaseTx Copper or Fiber Optic Uplink SFP
 - d) Provide a 48VDC Power Supply used to provide the PoE Power
 - 3) 8 RJ45 Port Model:
 - a) 8 RJ45 ports - 10/100 BaseTx Copper
 - b) 2 Combo ports - 10/100/1000 BaseTx Copper or Fiber Optic Uplink SFP
- 2. Managed Ethernet Switch Schedule:
 - a. Shall be furnished and installed for the following applications:
 - 1) 16 RJ45 Ports:
 - 2) As required by other specifications sections. 12 + 4 PoE RJ45 Ports:
 - 3) As required by other specifications sections. 8 RJ45 Port Model:
 - b. As required by other specifications sections. Refer to the Control Panel Layouts and Network Diagrams within the Engineers Drawings for Quantity and Details.
- 3. Manufacturer/Model:
 - a. Allen Bradley Stratix 5700
 - 1) SFP Modules required only as needed
 - b. Prior Approved Equal

R. Copper Patch Panels

- 1. General Specifications:
 - a. Modules:
 - 1) Mini-Com Copper Jack Module: CJ688TG
 - 2) Jack Module Color: Refer to Section 40 67 13
 - b. Physical:
 - 1) Mounting: DIN Rail
 - 2) Cable Entry: Cable Entry Grommet
- 2. Copper Patch Panel Schedule:
 - a. Shall be furnished and installed in the following application(s):

- b. As required by other specifications sections. Refer to the Control Panel Layouts and Network Diagrams within the Engineers Drawings for Quantity and Details.
 - 3. Manufacturer/Model:
 - a. Panduit CDPP8RG
 - b. OCC
 - c. Prior Approved Equal
- S. Uninterruptible Power Supply's (UPS)
 - 1. General Specifications:
 - a. UPS shall be wired as the first device receiving power.
 - b. Provide a UPS bypass relay for maintenance purposes.
 - c. UPS shall be sized appropriately to handle the full load connected to them including the control panel and any other required external devices, instrumentation, analytical devices.
 - 1) Provide an additional 50% spare operating capacity
 - 2) Power calculations showing the required load with additional spare capacity shall be provided during the submittal phase
 - d. Reliable, true online, high frequency, double conversion type with batteries for critical type applications in high harmonic and/or noisy electrical installations.
 - e. Input / Output Voltage: 120 VAC
 - f. True sine wave AC output.
 - g. Outlets (Minimum): Five (5)
 - h. Battery:
 - 1) Type: Sealed Lead Acid Battery
 - 2) Voltage: 12VDC
 - 3) Capacity (Minimum): 5.5Ah
 - 4) Operating Temperature: 32°F to 122°F
 - 5) Provide Extended Battery Modules (EBM) as Indicated in the E Drawings
 - 6) Manufacturer/Model:
 - a) Allen Bradley 1609-HBAT
 - b) Prior Approved Equal
 - i. Shall have a programable relay for notifying the PLC.
 - j. Connectivity Card:
 - 1) Ethernet Network Card: NETWORK-M2
 - 2) Industrial Relay Card: INDRELAY-MS
 - 2. Uninterruptible Power Supply's (UPS) Schedule:
 - a. Shall be furnished and installed for the following application(s):

- 1) In each Control Panel.
- b. Refer to the E and IC Drawings within the Engineers Drawings for Quantity and Details.
- c. Manufacturer/Model:
 - 1) Eaton 9SX
 - 2) Prior Approved Equal

PART 3 EXECUTION

3.01 FACTORY WITNESS TEST

- A. Complete factory witness testing including (but not limited to) the following equipment:
 1. Control Panels and Networking Equipment as specified in this Section 40 53 13.
- B. The Owners representative will provided all necessary network equipment as indicated in the Construction Documents as being Owner furnished to complete a fully functional witness test of the Ethernet I/P protocol control scheme.
- C. The OEM system manufacturer shall provide all required cabling and patch cords to fully connect all equipment to the network switches as to provide a complete and functional system during the factory witness test.

3.02 INSTALLATION/WORKMANSHIP

1. The workmanship and design of this equipment shall conform to all national, state and local electrical codes and ordinances that apply. The control system manufacturer shall provide complete electrical schematic wiring (factory and field) diagrams showing all components together with a description of system operation. Complete information to adjust and service this equipment shall be included.
2. Wire Labels: All wires both those factory terminated by the OEM system manufacturer as well as field wiring terminated by the Electrical Contractor to the Control Panel shall be provided with printable heat shrink labels installed on the wire prior to termination. All markers shall be positioned such that they can be clearly read by anyone looking at them with out having to adjust the wire positioning.

3.03 CONTROL SYSTEM MANUFACTURER SERVICES

- A. The control system manufacturer shall provide information to the Contractor on the proper installation of Category 6 Ethernet communications cable.
- B. The services of a factory trained, qualified service representative that is part of the permanent staff of the OEM system manufacturer shall be provided to inspect

the complete equipment installation to insure that it is installed in accordance with the manufacturers recommendations and for commissioning the project.

- C. Provide final calibration of all instrumentation before shipping. Provide coordination necessary for the correction of interface deficiencies between instrumentation, control panels, control equipment, and final control devices. Provide written documentation on the problems found detailing device names and tags, tests conducted, diagnosis, and corrective action to be taken.
 - 1. Perform all control panel wiring terminations and all field device wiring terminations.
- D. Configure all instrumentation and control devices supplied, modified, or relocated as part of this project. Configuration shall include:
 - 1. Configuration of transmitters to work with measuring elements.
 - 2. Scaling of transmitters to transmit appropriate analog (4-20 mA) signal based on minimum and maximum operating range of process value being measured. Operating ranges for each device will be provided during construction.
- E. Verify that each instrumentation and control device is wired and operating correctly by going "online" with each PLC, testing each field device, and witnessing correct action in the PLC through the programming software.
- F. Provide Engineer with a signed certificate for each control panel stating that each device wired to it has been checked out and has been verified to be operating correctly.
 - 1. Assign and configure a temporary IP address to each PLC Ethernet module and touch panel computer and verify that each device can be "pinged" from the corresponding Ethernet switch. Provide verification in writing to the Engineer. IP addresses will be provided by Engineer upon approval of the shop drawings.

3.04 PROGRAMMABLE LOGIC CONTROLLER (PLC) INSTALLATION

- A. Refer to Section 40 63 43 for details.

3.05 SUPPLIES AND SPARE PARTS

- A. Contractor shall provide all expendable items such as lamps, fuses, etc. for system startup, checkout, and during the acceptance test.
- B. At Final Completion, Contractor shall furnish the following expendable items:
 - 1. Twenty (20) percent spare fuses and lamps of each type furnished, but not less than six (6) of each type.

END OF SECTION 40 53 13

SECTION 40 61 13
PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Basic requirements for complete instrumentation system for process control.
2. Requirement for Contractor to subcontract the Process Control System portion of the work to a "Hardware System Integrator." See specifications contained within.
3. "Software System Integrator" services will be provided under a separate contract outside of the construction contract. See specifications contained within.
4. PLC and HMI programming and associated programming startup services are not required from the contractor as part of contractors bid. See specifications contained within.

1.02 QUALITY ASSURANCE

A. Referenced Standards:

1. The International Society of Automation (ISA):
 - a. 7.0.01 - Quality Standard for Instrument Air.
 - b. S5.1 - Instrumentation Symbols and Identification.
 - c. S5.3 - Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
 - d. S20 - Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
 - e. 62443-3-3 - Security for Industrial Automation and Control Systems, Part 3-3: System Security Requirements and Security Levels
2. National Electrical Manufacturers Association (NEMA):
 - a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
3. National Fire Protection Association (NFPA):
 - a. 70 - National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
 - a. 913 - Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.
5. National Institute of Standards and Technology (NIST)
 - a. SP 800-82 - Guide to Industrial Control Systems (ICS) Security

B. Qualifications:

1. Hardware System Integrator (HSI):
 - a. A single manufacturer who is skilled and experienced in the production of control systems shall furnish the automatic control system equipment. The manufacturer shall have the following experience:
 - 1) Have satisfactorily provided control system integration for a minimum of five projects of similar magnitude and function.
 - 2) Motor Control Centers.
 - 3) Level, flow, and pressure controls.
 - 4) Wastewater treatment, pumping facilities, and distribution systems.
 - 5) Ethernet/IP Network Telemetry systems.
 - b. Certification:
 - 1) UL508A Certification
 - 2) UL698A Certification
 - c. Qualification:
 - 1) Regularly engaged in the design and the installation of process control and instrumentation systems and their associated subsystems as they are applied to the municipal wastewater industry.
 - 2) Maintains a permanent, fully staffed and equipped service facility with full time employees capable of designing, documenting, fabricating, installing, calibrating, providing training services, and testing the systems specified herein.
 - 3) Capable of responding to on-site problems within 24 hours of notice. Provide an on-site response within 12 hours of notification starting at two months before scheduled startup to two months after startup completion.

C. Miscellaneous:

1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.03 DEFINITIONS

- A. Calibrate: To standardize a device so that it provides a specified response to known inputs.
- B. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

- C. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
- D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

1.04 SYSTEM DESCRIPTION

A. Control System Requirements

1. This Specification Section provides the general requirements for the control system.
2. The control system consists of all primary elements, transmitters, switches, controllers, computers, communication devices, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, software, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.
3. The control system shall be the result of the combined efforts of the Hardware System Integrator, Software System Integrator, and Electrical Contractor. Descriptions are provided as follows:

a. Hardware System Integrator (HSI)

NOTE, THE EQUIPMENT AND INSTRUMENTATION PROVIDED BY THE HARDWARE SYSTEM INTEGRATOR AS SPECIFIED HEREIN SHALL BE PROVIDED THROUGH THE DIVISION 26 ELECTRICAL CONTRACTOR .

The Hardware System Integrator shall be responsible for the following:

- 1) The design of all equipment required by these specifications and as indicated within the Engineer's drawings.
- 2) Testing of all equipment required by these specifications and as indicated within the Engineer's drawings.
- 3) All control panels, control panel components, network racks, network control panels, junction boxes, control stations and materials furnished in the control panels as identified by the following specifications and as indicated in the Engineer's drawings:

Section 40 63 13 - Process Control Panels and Hardware.

Section 40 63 14 - Junction Boxes and Control Stations.

Section 40 63 43 - Programmable Logic Controllers.

Section 40 67 13 - Network Racks and Equipment.

- 4) Each control panel component shall be factory mounted, wired, inspected, and factory tested as a complete system.
- 5) Purchasing all PLC panel materials and construction of PLC panels.
- 6) Provide hardware testing of all control panels, network racks, and local control stations.
- 7) The Hardware System Integrator shall provide their own PLC programming software for use in testing the hardware and communications.
- 8) Overseeing and verifying the communications cabling, fiber optic cabling, and all communications terminations required for operation of the PLC control system including Process Equipment PLC panels supplied in other sections.
- 9) Furnish all VFDs shown within the Engineer's Drawings unless noted otherwise.
 - a) Provide hardware testing of all Freestanding VFDs, and Motor Control Panels.
- 10) Provide the following primary process measurement devices / instrumentation as defined by 40 70 01 - Instrumentation General Requirements:

Section 40 71 00 - Flow Measurement

Section 40 72 00 - Level Measurement

Section 40 74 00 - Temperature Measurement

Section 40 75 00 - Process Liquid Analytical Measurement

Section 40 76 00 - Process Gas Analytical Measurement

The hardware system integrator shall be responsible for overseeing the installation and field calibration of all items supplied.

- 11) Work with Software System Integrator and Electrical Contractor to install an Ethernet Network as shown and indicated in the Engineering's drawings.

- 12) Overseeing and verifying the field connections and functionality of all sensors and devices provided in other sections of the specifications that are connected to the PLC system.
- 13) Assisting the Software System Integrator in the start-up and field verification of the various control loops in the system.
- 14) Generate the Hardware and Software O&M Manuals regarding all equipment supplied for the PLC control system. See specification Section 01 78 23 - Operation and Maintenance Data.
- 15) The Hardware System Integrator shall **NOT** be responsible for the following:
 - a) PLC control panels supplied by process equipment vendors.
 - b. Acceptable Hardware System Integrators are:
 - 1) Dakota Pump
 - a) Location: Mitchell, SD
 - b) Phone (605) 996-6636
 - 2) Or "Approved Equal"
 - c. Software System Integrator (SSI) - The Software System Integrator shall be under a separate contract outside of the construction contract to provide programming and start-up services for the Programmable Logic Controllers (PLCs), Operator Interfaces (OITs), Human Machine Interfaces (HMIs), Network System Configuration, Server Setup and Configuration, and Computer Workstation Setup and Configuration. This does not include PLC and/or OIT programming by OEM vendors.
 - 1) The Software System Integrator shall provide technical assistance to the Hardware System Integrator during the PLC panel hardware design.
 - 2) Coordinate with Process Equipment PLC panels supplied by equipment vendors on the project.
 - 3) Define and refine the control loop requirements with the Engineer.
 - 4) Develop and test PLC programs for the PLC Control System.
 - 5) Develop HMI software interface screens and reports.

- 6) Work with the Hardware System Integrator in the start-up phase for field verification of all control loops in the system. This shall exclude OEM based control loops.
 - 7) Generate the Software O&M Manuals for the HMI system
 - 8) Software System Integrator shall coordinate data communication between all OEM vendors.
- d. Electrical Contractor — The Electrical Contractor shall provide for the installation and wiring of the PLC Control System. All of the control wiring, signal wiring, and communication wiring and terminations will be provided by the Electrical Contractor.
- 1) Work with Hardware System Integrator to install an Ethernet Network as shown and indicated in the Engineering's drawings.
 - 2) Electrical Contractor shall be responsible for providing and installing all conduit and wire as shown on the Electrical Instrumentation and Control One Line Diagram series.
 - 3) It shall be the responsibility of the Electrical Contractor to provide a complete, fully operating and acceptable system. Drawings and Specification are intended to describe a complete installation for the purpose specified and to detail the scope of work for the Contractor.
 - 4) The Electrical Contractor shall be responsible for all detail that may be necessary to properly provide, and place in operation, the complete installation. The Contractor shall assume full responsibility for additional cost that may result from unauthorized deviation from the project documents.
- e. The Hardware System Integrator, Software System Integrator, and Electrical Contractor shall conduct a minimum of one meeting in person with the Engineer prior to the start of construction to go through the above responsibilities and submittal process for the project.

1.05 APPROVED EQUAL(S)

A. Hardware System Integrator

1. For full consideration of "Approved Equal" hardware system integrators, additional information must be provided no later than fourteen days prior to bid opening. The decision will be based on a pass/fail rating system and subjective to additional investigation by the Owner or Engineer. Additional information to be provided shall include the following:

2. The hardware system integrator shall have an active \$1,000,000 professional liability insurance policy.
3. To demonstrate financial stability, the hardware system integrator has completed a minimum of four past projects, each with an individual contract cost in excess of \$1,000,000.
4. Submit a financial prospectus indicative of the corporation's financial state. This prospectus shall also include:
 - a. A letter from a financial institution indicating a current line of credit and bonding limit which can be applied to this Project.
 - b. Latest annual report or reviewed financial statement.
5. The financial condition of the firm cannot be such that its financial ability to complete the Project is, in the opinion of the Owner, in doubt.
6. The hardware system integrator shall have in-house capability to handle complete system engineering, UL listed panel fabrication, instrument supply and calibration, commissioning, testing, and troubleshooting of the process control and instrumentation system.
7. The hardware system integrator shall be a firm specializing in the integration of control systems with documented experience in the detailed design, construction, configuration, and maintenance of PLC based control systems and variable frequency drive systems for the wastewater utility market.
8. Provide documentation to show the ability to complete NEMA Class IIS, Type B wiring diagrams for a Motor Control Center.
9. Provide a list of at least three successfully completed projects for a wastewater system of similar scope and complexity in which the proposing firm used components the same as those intended for use on this Project. In addition, provide the following information for each project:
 - a. Name of plant or system owner, contact name, and current telephone number. Design engineer's name, address, and telephone number.
 - b. Manufacturer and model number(s) of the PLC based control system and the computer-based PCS system used for both hardware and software.
 - c. Brief description of the system.
 - d. Contracted cost of the system, including change orders for the completed projects.
 - e. Duration of the project and date of completion.
10. Provide a clear description of the proposed (minimum) scope of supply for the proposed hardware system integrator. This scope description shall be binding and shall be considered the minimum scope of work for the proposing firm. The intent is to verify that proposing firms can and will perform the complete, minimum scope described above.
11. It is the responsibility of the submitting hardware system integrator to deliver sufficient information of each of the previously listed items to document compliance with the minimum requirements. Failure to submit all requested information shall result in disqualification. If it is discovered

at any time that any significant information submitted is incorrect, substantially misleading, or fraudulent, the submitting firm shall be subject to immediate disqualification from participation in the Project.

PART 2 - PRODUCTS

2.01 NEMA TYPE REQUIREMENTS

- A. Provide enclosures/housing for control system components in accordance with the area designations provided on the Drawings.
 - 1. Areas designated as wet: NEMA Type 4.
 - 2. Areas designated as wet and/or corrosive: NEMA Type 4X.
 - 3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
 - a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
 - 1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
 - 4. Areas designated as Class II hazardous, Groups E, F, or G as defined in NFPA 70:
 - a. NEMA Type 9 unless all electrical components within enclosure utilize intrinsically safe circuitry.
 - 1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
 - 5. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
 - 6. Areas designated to be subject to temporary submersion: NEMA 6P.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Unless stated otherwise, system operating criteria are as follows:
 - 1. Stability: After controls have taken corrective action, as result of a change in the controlled variable or a change in setpoint, oscillation of final control element shall not exceed two cycles per minute or a magnitude of movement of 0.5% full travel.
 - 2. Response: Any change in setpoint or change in controlled variable shall produce a corresponding corrective change in position of final control element and become stabilized within 30 seconds.
 - 3. Agreement: Setpoint indication of controlled variable and measured indication of controlled variable shall agree within 3% of full scale over a 6:1 operating range.
 - 4. Repeatability: For any repeated magnitude of control signal, from either an increasing or decreasing direction, the final control element shall take

a repeated position within 0.5 % of full travel regardless of force required to position final element.

5. Sensitivity: Controls shall respond to setpoint deviations and measured variable deviations within 1.0% of full scale.
6. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.03 ACCESSORIES

- A. Provide identification devices for instrumentation system components in accordance with Specification Section 26 05 53 - Identification for Electrical Systems.
- B. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.01 FIELD QUALITY CONTROL

- A. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.
- B. Instrumentation Calibration:
 1. Verify and document that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
 - a. Utilize the Instrument Certification Sheet located at the end of this Specification Section (or Engineer approved equivalent) to document on-site calibration checks.
 2. Factory furnished calibration certifications are acceptable for the following:
 - a. Flow meters.
 - b. Pressure sensors utilized with annular sleeve.
 - c. Temperature sensors.
 3. On-site calibration verification is required for all other instruments, including "smart" transmitters that have been factory calibrated.
 - a. Provide calibration checks at 0 PCT, 25 PCT, 50 PCT, 75 PCT and 100 PCT of span for pressure transmitters and gages.
 - 1) Check for both increasing and decreasing input signals to detect hysteresis.
 - b. In addition to factory calibration certification, temperature sensors and gages shall be checked at a single point for conformance to required accuracy.

- c. Level transducers/transmitters shall be checked at two points in addition to zero.
- d. Analytical sensors shall be calibrated in accordance with manufacturer's recommendations.
- e. Check operation of all switches to verify actuation occurs in accordance with manufacturer's specified accuracy.
- f. Replace any instrument which cannot be properly adjusted.
- g. Stroke pneumatic control valves with clean dry air to verify control action, positioner settings, and solenoid functions.
- 4. Calibration equipment shall be certified by an independent agency with traceability to NIST.
 - a. Certification shall be up-to-date.
 - b. Use of equipment with expired certifications shall not be permitted.
- 5. Calibration equipment shall be at least three times more accurate as the device being calibrated.

C. Loop Check-Out Requirements are as Follows:

- 1. Work closely with the Owner to check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections. Loop check-out work shall verify proper operation of the installed equipment and the Owner's PLC and HMI programming.
 - a. Use actual signals where available.
 - b. Closely observe controllers, indicators, transmitters, HMI displays, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components.
 - 1) Verify that readings at all loop components are in agreement.
 - 2) Make corrections as required.
 - a) Following any corrections, retest the loop as before.

D. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.

- 1. Check all interlocks to the maximum extent possible.
- 2. Utilize the Loop Check-Out Sheet located at the end of this Specification Section (or Engineer approved equivalent) to document on-site calibration checks.
- 3. In addition to any other As-Recorded Documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

END OF SECTION 40 61 13

SECTION 40 63 13
PROCESS CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.01 SUMMARY

NOTE, THE HARDWARE SYSTEM INTEGRATOR AS SPECIFIED HEREIN SHALL PROVIDE THE EQUIPMENT LISTED IN THE 'PART 2' SECTIONS BELOW THROUGH THE DIVISION 26 ELECTRICAL CONTRACTOR.

A. Description

1. Complete PLC based control system with Supervisory Control and Data Acquisition (SCADA) functions.
2. This section is intended to cover all work necessary for the procurement of the wastewater system facility process control and instrumentation equipment. This includes all specified and required equipment installed and place into acceptable operation as herein described.

B. Responsibility and Coordination

1. It shall be the responsibility of the Contractor to provide a complete, fully operating and acceptable system. Drawings and Specification are intended to describe a complete installation for the purpose specified and to detail the scope of work for the Contractor.
2. The Contractor shall be responsible for all detail that may be necessary to properly provide, and place in operation, the complete installation. The Contractor shall assume full responsibility for additional cost that may result from unauthorized deviation from the project documents.

C. Approved Equal(s)

1. Hardware or Equipment
 - a. The naming of a manufacturer of equipment in this Specification is not intended to eliminate competition or prohibit qualified manufacturers from offering equipment. Rather, the intent is to establish a minimum standard of quality, and to indicate a principle of operation desired for this project. Other manufacturers of similar system controls are encouraged to submit for prior approval.
 - b. No hardware system integrator, or their agent or supplier, shall submit for approval without the full understanding on the part of that the hardware system integrator, Contractor, agent or supplier, may be rejected, and that the Engineer will use his own judgment; and that his decision is final. In the event of adverse decision, no claim of any sort or kind shall be made against the Owner or Engineer.

D. Testing Agency Certification

1. All new panels and control system junction boxes furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment" or Underwriter's Laboratories (UL) Standard 698 - "Industrial Control Equipment for Use in Hazardous (Classified) Locations".
2. Each panel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard UL 508A or UL 698A.

E. Delivery, Storage, and Handling

1. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed and permanent connections are made.

F. Work Items Specified Under This Section

1. General Control System Scope.
2. System Control Panels.
3. Control Panel Components.
4. Hardware System Integrator Required Services.

1.02 SUBMITTALS

- A. Submit shop drawings in accordance with Specification Section 01 33 00 - Submittal Procedures. The following information shall be included within each submittal as required by the type of equipment or instrumentation that is being submitted on by the system manufacturer. The following information is not required to be in this order. All submittals are required to have the following information if applicable or will be subject to rejection.

1. PDF Bookmarks for Ease of Submittal Navigation
2. Equipment Cut Sheets
 - a. Cut sheets detailing all relevant information shall be provided for all equipment/components that will be used.
 - 1) Physical limitations of components including high and low temperature limits shall be identified.
 - b. All cut sheets shall be clearly highlighted indicating specific part number buildout for all equipment and components.
3. Bill of Materials
 - a. Bill of materials shall be provided for each enclosure provided detailing equipment and components being utilized.
4. Power Calculations
 - a. Power calculations shall be provided for the following if they are present:

- 1) Control Panel incoming power per phase
 - 2) 24VDC Power Supply
 - 3) UPS
5. Heat Calculations
 - a. Heat calculations shall be provided for the following if they are present:
 - 1) Indoor Enclosures with Heat Emitting Equipment in or Near the Enclosure
6. I/O Schedules
 - a. An I/O schedule shall be provided for each control panel.
7. Control Panel, Junction Box, Network Rack, and MCC Bucket Details and Layouts
 - a. NEMA ratings of all equipment shall be clearly identified.
 - b. Identify electrical power requirements of each assembled
 - c. Provide detailed layouts of all equipment. Identify overall dimensions and provide estimated weight of assembled equipment.
 - d. Nameplate layout drawings shall be provided.
8. Loop Control Drawings
 - a. Loop control drawings shall be provided that detail all electrical connections to/from and inside the CP, NWP, or MCC. This includes but is not limited to the following:
 - 1) Tag Names
 - 2) Terminal Block Numbering
 - 3) Conductor Type
 - 4) Conductor Quantity
 - 5) Conductor Jacket Color
 - 6) Hard Wired Logic (Relays, Switches, etc...)
9. Provide drawings and layouts in both PDF and AutoCAD electronic formats.

1.03 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's data in accordance with Specification Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The system controls, alarms, and telemetry shall be constructed as shown on drawings and herein described.

2.02 PROCESS CONTROL PANEL

A. Control Panel Enclosures

1. The control panels shall include the following
 - a. Enclosure with back panel and mounting provisions.
 - b. Enclosures shall be stainless steel type 304 for general use. Type 316 stainless steel shall be utilized in caustic environments.
 - c. Interior light activated by door switch provided for each door of the enclosure.
 - d. Transient and surge suppression for power and control input/output.
 - e. Linear regulated DC power supplies. Power supplies shall be UL listed for use in type 508A or 698A Industrial Control Panels as required: AC power input fusing AC power transient protection current Limiting AC "power on" indication.
 - f. Separate terminal blocks for inputs and outputs.
 - g. GFCI receptacle outlet (120V).
 - h. Programmable logic controller with I/O modules as required.
 - i. Lockable door handle.
 - j. Inner door pocket for storing wiring diagrams.
 - k. 18"x18" fold up programming shelf on all free standing enclosures.
 - l. See E drawings for door mounted devices and associated labeling.
 - m. Enclosure size shall be selected based off of equipment as shown in the E Drawings and within this specification. Any enclosure sizing shown within the drawings are to be used as a minimum size. It is up to the hardware system integrator to increase the size of any enclosure to ensure all equipment fits with reasonable space remaining.
2. Enclosure Schedule:
 - a. Control Panel Enclosure(s) shall be furnished and installed for the following application(s):
 - 1) NEMA Type 12 Painted Steel
 - a) Wall Mounted
 - (1) EB-SCP1
 - (2) PTB-SCP1
3. Manufacturer/Model:
 - a. Hoffman
 - b. SCE
 - c. Prior Approved Equal

B. Panel Heater

1. Manufactured unit with aluminum housing and integral thermostat and 0°F to 100°F adjustable range.

2. Provide quantity and size as required to meet temperature requirements specified.
3. UL labeled
4. Panel Heater Schedule:
 - a. Refer to the Control Panel Drawings and Typical Wiring Schematics within the Engineers Drawings for quantity and requirements.
5. Manufacturer/Model:
 - a. Hoffman DAH Series
 - b. Prior Approved Equal

2.03 PROCESS CONTROL PANEL COMPONENTS

A. Main Breaker

1. General Specifications:
 - a. Frame Size: H-Frame Thermal Magnetic Molded Case
 - b. Breaker Type: Thermal Magnetic Molded Case
 - c. Interrupting Rating: 65kA @ 240Vac, 35kA @ 480Vac
 - d. Termination: Lugs (Both Ends)
2. Install thru-door handle as needed where handles are installed on the front of the enclosure.
3. Main Breaker Schedule:
 - a. Refer to Panel Schedules in Engineers Drawings for Control Panels requiring main breakers.
4. Manufacturer/Model:
 - a. SquareD
 - b. Prior Approved Equal

B. Miniature Circuit Breakers

1. General Specifications:
 - a. UL489 Branch Protection
 - b. Trip Curves
 - 1) C Trip Curve: Low/Medium Inrush Applications
 - 2) D Trip Curve: High Inrush Applications (Motors)
 - c. SCCR (Minimum): 10kAIC
 - d. Breaker Status Indicator
 - e. Utilize 1-pole, 2-pole, and 3-pole breakers within the control panels as indicated below and as shown in the typical wiring schematics found within the E Drawings.
 - f. Shall be furnished and installed for the following applications:
 - 1) 1-Pole
 - a) Incoming Power Feed
 - b) Internal Panel Components
 - (1) 24VDC Power Supply (120Vac Input)
 - (2) 24VDC Power Supply (24Vdc Output)

- (3) Programmable Logic Controller (PLC)
 - (4) Operator Interface Terminal (OIT)
 - (5) Ethernet Switch
- c) Flow Measurement Transmitters
- d) Analytical Transmitters
- e) Gas Transmitters
- f) Electric Actuated Valves
- 2) 2-Pole
 - a) Incoming Power Feed
- g. Manufacturer/Model:
 - 1) Allen Bradley
 - 2) Phoenix Contact TMC 8 Series
 - 3) Eaton FAZ
 - 4) SquareD Multi 9
 - 5) Prior Approved Equal

C. Fused Terminals

- 1. General Specifications:
 - a. DIN rail mounted, touch safe, modular type
 - b. Minimum Rated Voltage: 250V RMS
 - c. Rated Current: As required per application
 - d. Physical Dimensions: 1/4" x 1 1/4" Standard Fuses
 - e. Blown fuse indicator light
 - f. Manufacturer/Model:
 - 1) Allen Bradley
 - 2) Phoenix Contact UT 6-HESILA
 - 3) Weidmuller
 - 4) Prior Approved Equal

D. Terminal Blocks

- 1. General Specifications:
 - a. DIN rail mounted, touch safe, modular type.
 - b. Minimum Rated Voltage: 600V RMS
 - c. Minimum Rated Current: 24 amps or higher as required per application
 - d. Connector metal body material: Copper alloy, min 85% copper with nickel or tin plating
 - e. Terminal screw material: Bronze with tin plating
 - f. Terminal Block Characteristics:
 - 1) It shall terminate wires without additional preparation: i.e. tinning of wire ends, application of ferrules, etc.

- 2) All shall have a nominal conductor termination acceptance of 4mm^2 . The one exception is that 2.5mm^2 shall be allowed for use within the MCC control circuitry as long as the required conductor and ampacity ratings are met.
 - 3) The insulation housing shall have primary entry funnels to facilitate insertion of wires.
 - 4) The insulation housing shall prevent stray strands from shorting to adjacent terminal blocks.
 - 5) Terminal screws shall be captive in the metal body or via the insulation housing.
 - 6) Once tightened the terminal screws shall be locked in place to prevent loosening due to shock and vibration.
 - 7) The terminal block shall be useable with accessories such as center or insertion bridges, test sockets, separating plates, end covers, etc. The accessories used shall also be touch safe.
 - 8) For wire identification, the terminal block shall provide space for marking with pre-marked labels. Handwritten labels shall not be allowed.
- g. Manufacturer/Model:
- 1) Allen Bradley 1492-J4
 - 2) Phoenix Contact UT 4
 - 3) Weidmuller WDU 4
 - 4) ABB
 - 5) Prior Approved Equal
 - 6) No Exceptions

E. Control Relays

1. General Specifications:
 - a. Blade plug-in type with dust cover and socket.
 - b. Coil (Continuous Operation):
 - 1) Voltage (Unless Noted Otherwise): $120\text{VAC} \pm 10\%$
 - c. Contacts:
 - 1) DPDT Minimum
 - 2) Voltage: 240VAC

- 3) Current: 10A
 - a) Lower current rated contacts shall be allowed as long as the circuit passing through the contacts has adequate overcurrent protection.
- d. Operating Time:
 - 1) Energization (Nominal): 35 milliseconds
 - 2) De-energization (Nominal): 100 milliseconds
- e. Mechanical Life: 10⁶ operations
- f. Operating Temperature: 0°C to 70°C
- g. Indicating LED or Flag
- h. Relay clip shall be provided and installed for all control relays.
- 2. Spares:
 - a. 10%, Minimum of Two (2) Plug-In Type Relay of each type used.
- 3. Manufacturer/Model:
 - a. Allen-Bradley
 - b. Phoenix Contact RIF-4-RSC-LV-120AC/3x21
 - c. Idec
 - d. Prior Approved Equal

F. Surge Suppressor

- 1. 120VAC Control Power
 - a. General Specifications:
 - 1) 120 VAC In-Line Device
 - 2) Max Continuous Voltage: 150 V
 - 3) Max Continuous Current: 25 A
 - 4) Measured Limiting Voltage: 760 V
 - 5) Nominal Discharge Current: 3 kA
 - 6) Response Time: < 25ns
 - 7) Connection Type: Screw
 - 8) Mounting: DIN Rail
 - 9) Style: Plug w/ Base
 - 10) Dry Contact Status Indicator
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) On any control panel being supplied with 120VAC as power.

- c. Manufacturer/Model:
 - 1) Phoenix Contact - 2910356
 - 2) Citel DS72US-120S/G
 - 3) Critec Equal
 - 4) Prior Approved Equal
- 2. 120VAC Digital I/O
 - a. General Specifications:
 - 1) Max Continuous Voltage: 150 V
 - 2) Max Continuous Current: 10 A
 - 3) Nominal Discharge Current: 2.5 kA
 - 4) Response Time: < 25ns
 - 5) Connection Type: Screw
 - 6) Mounting: DIN Rail
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) On any 120VAC digital I/O signal that goes outside of a building or control panel underground.
 - c. Manufacturer/Model:
 - 1) Phoenix Contact - TermiTrab TTC-6-MOV-C-120AC-UT-I
 - 2) Prior Approved Equal
- 3. VDC Analog I/O
 - a. General Specifications:
 - 1) Max Continuous Voltage: 28 V
 - 2) Max Continuous Current: 450 mA
 - 3) Nominal Discharge Current: 10 kA
 - 4) Response Time: < 1ns
 - 5) Connection Type: Screw
 - 6) Mounting: DIN Rail
 - 7) Style: Plug w/ Direct Grounding Base
 - b. Surge Suppressor Schedule:
 - 1) Shall be furnished and installed for the following applications:

- a) On any analog I/O signal that goes outside of a building underground.
- c. Manufacturer/Model:
 - 1) Phoenix Contact - TermiTrab TTC-6P-1x2-24DC-UT-I
 - 2) Prior Approved Equal

G. Intrinsically Safe Barriers

1. VDC Isolators

- a. General Specifications:
 - 1) Power Input Voltage: 24VDC
 - 2) Maximum Input Voltage: 27.2VDC
 - 3) Maximum Input Current: 50mA
 - 4) Operating Temperature: -20°C to +60°C
 - 5) Two-Channel with line fault detection and phase reversal
 - 6) Two relays with changeover contacts
 - 7) Din rail mounted
 - 8) UL labeled unit suitable for using non rated devices in NEC Class 1, Division 1 Group D explosive area
 - 9) Standards: NAMUR/DIN 19234
- b. Intrinsically Safe Barrier Schedule:
 - 1) Shall be furnished and installed for the following applications:
 - a) Each Analog or Digital signal within a C1D1 rated control panel or from a C1D1 location.
 - b) Each individual lift station float switch or flood switch circuit
- c. Manufacturer/Model:
 - 1) PR Electronics
 - a) Analog PN: 5104B
 - b) Analog (HART) PN: 9106B
 - c) Discrete PN: 5202B
 - 2) Eaton
 - a) Analog PN: MTL7787+
 - b) Discrete PN: MTL5018
 - 3) Prior Approved Equal

H. Uninterruptible Power Supply (UPS)

1. General Specifications:

- a. UPS shall be wired as the first device receiving power.
- b. Provide a UPS bypass relay for maintenance purposes.
- c. UPS shall be sized appropriately to handle the full load connected to them including the control panel and any other required external devices, instrumentation, analytical devices.
 - 1) Provide an additional 50% spare operating capacity
 - 2) Power calculations showing the required load with additional spare capacity shall be provided during the submittal phase
- d. Reliable, true online, high frequency, double conversion type with batteries for critical type applications in high harmonic and/or noisy electrical installations.
- e. Input / Output Voltage: 120 VAC
- f. True sine wave AC output.
- g. Outlets (Minimum): Five (5)
- h. Battery:
 - 1) Type: Sealed Lead Acid Battery
 - 2) Voltage: 12VDC
 - 3) Capacity (Minimum): 5.5Ah
 - 4) Operating Temperature: 32°F to 104°F
 - 5) Provide Extended Battery Modules (EBM) as Indicated in the E Drawings
 - 6) Manufacturer/Model:
 - a) Eaton P/N: 9SXEBM48
 - b) Prior Approved Equal
- i. Shall have a programmable relay for notifying the PLC.
- 2. Uninterruptible Power Supply (UPS) Schedule:
 - a. Refer to the E and IC Drawings within the Engineers Drawings for Quantity and Details.
- 3. Manufacturer/Model:
 - a. Eaton 9SX
 - b. Prior Approved Equal

I. DC Power Supply

- 1. Linear regulated DC power supplies.
- 2. Power supplies shall be U.L. listed for the use in type 508 or 698 Industrial Control Panels as required and abide to the following requirements:
 - a. 120 VAC power input.
 - b. Fusing (circuit protection) on AC power.
 - c. Transient protection.
 - d. Current Limiting.

- e. AC "power on" indication.
 - f. DIN rail mountable.
- 3. Power supplies shall be sized appropriately to handle the full load connected to them.
 - a. Provide an additional 50% spare capacity.
 - b. Power calculations showing the required load with additional spare capacity shall be provided during the submittal phase.
- 4. DC Power Redundancy Modules:
 - a. Where required within the electrical drawings and as indicated within these specifications.
 - b. Power supplies with built in power redundancy shall be allowed. Two or more power supplies of this type shall be paralleled for this configuration depending on the power requirements of the system.
- 5. Manufacturer/Model:
 - a. Allen-Bradley
 - b. Phoenix Contact
 - c. PULS
 - d. Prior Approved Equal
- J. Programmable Logic Controllers (PLC)
 - 1. See 40 63 43 - Programmable Logic Controllers.
- K. Operator Interface Terminals (OIT)
 - 1. General Specifications:
 - a. Screen:
 - 1) Size: As Indicated Below
 - 2) Type: Color TFT
 - 3) Input Type: Touch
 - b. Communications: Ethernet TCP/IP – 10/100
 - c. Memory:
 - 1) On board memory
 - 2) USB Port for Data storage and application backup
 - d. Power: 24VDC
 - 2. Operator Interface Terminals (OIT) Schedule:
 - a. Shall be furnished and installed in the following application(s):
 - 1) Size: 10.0-inch
 - a) EB-SCP1
 - b) PTB-SCP1
 - b. Manufacturer/Model:
 - 1) Allen Bradley Panel View Plus 7
 - a) Standard

- 2) Prior Approved Equal

L. Control Switches

1. Electronic Circuits:
 - a. General Specifications:
 - 1) Type (As Required):
 - a) Selector
 - b) Momentary Selector
 - c) Momentary Pushbutton
 - 2) Contacts (As Required):
 - a) Heavy Duty
 - b) Oil Tight
 - 3) Contacts:
 - a) Gold Flashed
 - b) Resistance: 0.01 Ohms
 - c) Rated Voltage: 120VAC
 - d) Rated Current: 0.5A
 2. Control Circuits:
 - a. General Specifications:
 - 1) Type (As Required):
 - a) Selector
 - b) Momentary Selector
 - c) Momentary Pushbutton
 - 2) Contacts (As Required):
 - a) Heavy Duty
 - b) Oil Tight
 - 3) Contact Rating: NEMA A-600
 3. Manufacturer/Model:
 - a. Allen-Bradley Bulletin 800T/H
 - b. Prior Approved Equal

M. Indicator Lights

1. General Specifications:
 - a. Nominal Package Diameter: 30mm
 - b. Lamp Type: LED
 - 1) Lamp shall be easily replaceable
 - c. Type: Push to Test
 - d. Lens Color: As Shown on Drawings
 - e. Contacts (As Required):
 - 1) Heavy Duty
 - 2) Oil Tight

- f. Ratings: NEMA 4
- 2. Manufacturer/Model:
 - a. Allen-Bradley Bulletin 800F
 - b. Prior Approved Equal

N. Managed Ethernet Switches

Note, Managed Ethernet Switches noted here is also to provide a reference for OEM control panels being furnished as part of Division 41 and Division 46 in addition to all system integrator provided control panels. This is an effort to set a standard of quality and continuity throughout the entire project.

- 1. General Specifications:
 - a. Performance:
 - 1) Managed
 - 2) Store & Forward
 - 3) Wire Speed Switching
 - 4) All IEEE 802.3 Ethernet protocols supported
 - b. Input Power Voltage: 12-48VDC
 - c. Environmental Conditions:
 - 1) Operating Temperature: -40°C to 60°C
 - 2) Storage Temperature: -40°C to 85°C
 - 3) Humidity (non-condensing): 5% to 95% RH
 - d. Mounting: Din Rail
 - e. Software: Full Version, Layer 2 Firmware
 - f. Ports: (2 SFP Ports Maximum)
 - 1) 8 Copper - 2 Combo:
 - a) 8 RJ45 ports - 100/1000 BaseTX Copper
 - b) 2 Combo ports - 100/1000 BaseTX Copper or Fiber Optic Uplink SFP
 - g. Ports: (4 or More SFP Ports and/or PoE)
 - 1) 8 Copper - 4 Combo:
 - a) 4 RJ45 ports - 10/100/1000 BaseTX Copper
 - b) 4 Combo port - 10/100/1000 BaseTX Copper or Fiber Optic Uplink SFP
- 2. Managed Ethernet Switch Schedule:
 - a. Shall be furnished and installed for the following applications:
 - b. Refer to the Control Panel Layouts and Network Diagrams within the Engineers Drawings for Quantity and Details.
- 3. Manufacturer/Model:
 - a. Allen Bradley Stratix 5200

1) SFP Modules required only as needed

b. Prior Approved Equal

PART 3 - EXECUTION

3.01 FACTORY WITNESS TEST

- A. Complete factory witness testing including (but not limited to) the following equipment:
 - 1. Motor Control Centers as specified in Section 26 24 19.
 - 2. All standalone VFDs as specified in Section 26 29 23.
 - 3. Control Panels as specified in Section 40 63 13.
 - 4. Networking Equipment as specified in Section 40 67 13.
- B. The Owners representative will provide all necessary network equipment as indicated in the Construction Documents as being Owner furnished to complete a fully functional witness test of the Ethernet I/P protocol control scheme.
- C. The Systems Integrator shall provide all required cabling and patch cords to fully connect all equipment to the network switches so as to provide a complete and functional system during the factory witness test.
- D. The Hardware System Integrator shall provide their own PLC programming software used for testing the hardware and communication between equipment.

3.02 INSTALLATION

- A. Wherever feasible, use bottom entry for all conduit entry into electrical control enclosures identified in this section, 40 63 14 - Junction Boxes and Control Stations, and instruments to the extent possible
- B. Install electrical components per the requirements of the Electrical design.

3.03 INSTALLATION/WORKMANSHIP

- A. The workmanship and design of this equipment shall conform to all national, state and local electrical codes and ordinances that apply.
- B. The control system manufacturer shall provide complete electrical schematic wiring (factory and field) diagrams showing all components together with a description of system operation. Complete information to adjust and service this equipment shall be included.
- C. Wire Labels: All wires both those factory terminated by the Systems Integrator as well as field wiring terminated by the Electrical Contractor to the Control Panel shall be provided with printable heat shrink labels installed on the wire prior to

termination. All markers shall be positioned such that they can be clearly read by anyone looking at them without having to adjust the wire positioning.

3.04 PROGRAMMABLE LOGIC CONTROLLER (PLC) INSTALLATION

- A. Refer to Section 40 63 43 for details.

3.05 SUPPLIES AND SPARE PARTS

- A. Contractor shall provide all expendable items such as lamps, fuses, etc. for system startup, checkout, and during the acceptance test.
- B. At Final Completion, Contractor shall furnish the following expendable items:
 - 1. Twenty (20) percent spare fuses and lamps of each type furnished, but not less than six (6) of each type.

END OF SECTION 40 63 13

SECTION 40 63 14
JUNCTION BOXES AND CONTROL STATIONS

PART 1 - GENERAL

1.01 SUMMARY

- A. Refer to section 40 63 13 - Process Control Panels and Hardware.

PART 2 - PRODUCTS

2.01 CONTROL STATIONS AND JUNCTION BOXES

- A. Enclosures for control stations and junction boxes shall meet the following minimum requirements:
1. Steel or Stainless steel and NEMA Ratings as noted on drawings.
 2. Minimum dimensions as indicated on the Drawings. Increase the size of each panel or junction box to fit equipment as required at no additional cost. Confirm size of each panel and junction box with the submittals.
 3. Control stations and junction boxes shall be flanged, corners welded and ground smooth.
 4. All non-stainless steel enclosure interior and exterior surfaces treated to prevent oxidation and painted. White on interior, manufacturer's standard color on exterior.
 5. Stainless Steel enclosures shall not be painted although the surface shall be treated as it normally would to prevent oxidation.
- B. All components and terminals labeled per shop drawings.
1. Engraved labels attached with screws or rivets.
- C. All wiring terminated on terminal strips per Section 40 63 13. Terminal strips shall be labeled with engraved plastic labels.
1. Labels shall be attached with two-part epoxy adhesive.
 2. 600 volt terminal strips.
 3. Ring or spade type crimp connectors.
 4. Wiring laced using plastic wire ties and plastic wiring troughs.
 5. Wiring held down with straps attached to enclosure with screws.
 6. Separate power, control, and signal conductors.
 7. Control wiring: #16 AWG, stranded, 600V copper minimum.
 8. Signal wiring: shielded, 600V, copper minimum.
 9. Provide 15 amp, 10000 AIC breaker on power circuits using #14 wire.
 10. Connections to instruments via terminal strip or connectors. Soldering wires to terminal strips is not acceptable.

D. Schedule

1. Control stations and junction boxes shall be furnished and installed as per the locations indicated within the E drawings.

E. The control panel drawings as furnished by the Hardware System Integrator specified in section 40 61 13 - Process Control System General Requirements shall fully incorporate all control stations and junction boxes including exact terminal numbers such that the entire circuit from the control panel to the load including the junction box is fully captured within the control panel drawings.

F. Manufacturer/Model:

1. NEMA 12 and 3R Stainless Steel
 - a. Hoffman
 - b. SCE
 - c. Prior Approved Equal
2. NEMA7, 9
 - a. Adalet
 - b. Prior Approved Equal

PART 3 - EXECUTION

3.01 SUMMARY

- A. Refer to section 40 63 13 - Process Control Panels and Hardware.

END OF SECTION 40 63 14

SECTION 40 63 43
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes
 - 1. Programmable logic controllers (PLC).
 - 2. Input and Output (I/O) modules.
 - 3. I/O connections and configurations.
 - 4. Spares.

1.02 REFERENCES

- A. Reference sections include, but are not limited to:
 - 1. NEMA ICS 1 - General Standards for Industrial Control and Systems.
 - 2. NEMA ICS 2 - Standards for Industrial Control Devices, Controllers and Assemblies.
 - 3. NEMA ICS 3 - Industrial Systems.
 - 4. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

1.03 SUBMITTALS - FOR REVIEW / APPROVAL

- A. Submit manufacturer's data in accordance with Specification Section 01 33 00 - Submittal Procedures.

1.04 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's data in accordance with Specification Section 01 78 23 - Operation and Maintenance Data including the following:
- B. Include bound copies of operating instructions.
- C. Include card replacement, adjustments, and preventative maintenance procedures and materials.
- D. Accurately record actual locations of controller cabinets and input and output devices connected to system. Include interconnection wiring and cabling information, and terminal block layouts in controller cabinets.

1.05 QUALIFICATIONS

- A. The Software System Integrator (SSI) will be providing all programming. See Section 40 61 13 - Process Control System General Requirements for approved software system integrators.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 01 61 00.
- B. Store and protect products under provisions of Section 01 61 00.
- C. Accept products on site in factory containers and verify damage.
- D. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

1.07 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature above 32 degrees F and below 104 degrees F during and after installation of products.
- B. Maintain area free of dirt and dust during and after installation of products.

1.08 MAINTENANCE SERVICE

- A. Provide a one (1) year warranty to correct equipment defects from the Date of Substantial Completion.

1.09 FURNISHING PARTY

- A. Programmable Logic Controller(s) may only be noted here to provide a reference for OEM control panels being furnished as part of Division 46 in an effort to set a standard of quality throughout the entire project. Other than the spare parts listed in Part 2 of this specification, the Systems Integrator as specified in Section 40 63 13 shall not be providing control panels utilizing PLC's other than listed within the control panel schedules noted within this specification and within the engineer's drawings.

PART 2 - PRODUCTS

2.01 PROGRAMMABLE LOGIC CONTROLLER(S)

- A. CompactLogix 5380 Platform (L3)
 - 1. The PLC system for each control panel shall be based on the Allen-Bradley (A-B) CompactLogix platform. Provide equipment as indicated on the Electrical Drawings and/or specifications and as required by the manufacturer.
 - 2. Each PLC system shall consist of a power supply, processor, communications modules, and I/O modules, as specified on the Electrical Drawings. In the occasion that the specified item is not available, Contractor must submit intent to use an alternate module to Engineer and receive approval from Engineer prior to installation of the alternate module.

<u>CompactLogix Item:</u>	<u>Mfg.</u>	<u>Part Number</u>
Power Supply (24VDC)	Allen-Bradley	1606-XLE240E
Processor	Allen-Bradley	5069-L320ER
Compact Flash Card	Allen-Bradley	1784-SDHC8

- a. See I/O Schedule for further details
3. Control Panel Schedule:
 - a. EB-SCP1

2.02 CHASSIS-BASED I/O MODULE(S)

A. CompactLogix 5380 I/O

1. Each PLC system shall use the following I/O modules. In the occasion that the specified module is not available, Contractor must submit intent to use an alternate module to Engineer.

<u>1769 CompactLogix Item:</u>	<u>Mfg.</u>	<u>Part Number</u>
Analog Input	Allen-Bradley	5069-IY4 & 5069-IF8
Analog Output	Allen-Bradley	5069-OF8
Digital Input (24VDC)	Allen-Bradley	5069-IB16
Digital Input (120VAC)	Allen-Bradley	5069-IA16
Relay/Contact Output	Allen-Bradley	5069-OW16
Ethernet/IP	Allen-Bradley	5069-AENTR
Field Potential Distributor	Allen-Bradley	5069-FPD
Address Reserve Module	Allen-Bradley	5069-ARM
Terminal Block	Allen-Bradley	Screw Type

2.03 I/O CONNECTION & CONFIGURATION

- A. All I/O points, including spares, must be factory wired to terminals as indicated in the typical wiring diagrams in the Electrical Plans. No field terminations may be made directly to the PLC Modules, with the exception of Flex I/O modules.
- B. All I/O points shall be wired to the points indicated in the I/O schedule found in the Electrical Plans.
- C. Programmable Controllers shall be manufactured to NEMA ICS 3 standards, with component circuit boards manufactured to NEMA ICS 2 standards.
- D. Service Conditions:
 1. Temperature: 0-60C
 2. Humidity: 5-95% without condensation
 3. Altitude: 5000 feet above sea level
- E. Configuration:

1. Processor Unit: Include processor, power supply, and battery backup
2. I/O: Provide by separate expansion units or by modular hardware units
3. I/O Capacity: As required, plus 25% or 4 points for each type whichever is greater

F. Ratings:

1. Scan Rate: 1 milliseconds per KByte

2.04 SPARES

- A. The Hardware Systems Integrator as specified in Section 40 63 13 shall provide the following spare PLC equipment. All equipment shall match that specified earlier in this section.

1. CompactLogix Platform:
 - a. One (1) – CompactLogix Power Supply
 - b. One (1) – CompactLogix Processor
 - c. One (1) – Field Potential Distributor
 - d. One (1) – Address Reserve Module
 - e. One (1) – Each CompactLogix IO module type

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as shown on Drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts conditions.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Connect input and output devices as shown on Drawings.
- D. The PLC processor shall be installed in the control panel and all I/O terminations shall be to screw terminals unless otherwise noted.
- E. Four (4) copies of all material shall be provided with final shipment. These copies shall be in addition to any required by other sections of these specifications.

- F. Provide the necessary time required for field installation and verification of all I/O devices with Electrical Contractor.

3.03 MANUFACTURER'S FIELD SERVICES

- A. Prepare and start systems under provisions of Section 01 75 00.
- B. Provide in writing to Engineer that installation and verification of all I/O devices has been performed.
- C. Provide the necessary time required for field I/O testing with Engineer.

3.04 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 01 75 00.
- B. Demonstrate operation of controller.

3.05 PLC PROGRAMMING

- A. All required PLC programming for Control Panels furnished by the Hardware System Integrator as specified in section 40 63 13 - Process Control Panels and Hardware shall be by the Software System Integrator.

END OF SECTION 40 63 43

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SECTION 40 67 13
NETWORK RACKS AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes
 - 1. Network Racks
 - 2. Patch Panels
 - 3. Networking Equipment
 - 4. Network Connections

1.02 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Specification Section 01 33 00 - Submittal Procedures.

1.03 OPERATION AND MAINTENANCE DATA

- A. Submit Operation and Maintenance data under provisions of Section 01 78 23 - Operation and Maintenance Data.
- B. Include bound copies of operating instructions.
- C. Include card replacement, adjustments, and preventative maintenance procedures and materials.

1.04 QUALIFICATIONS

- A. The Project Engineer will be providing all programming. See Section 40 63 13 - Process Control Panels and Hardware for approved control system manufacturers.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept products on site in factory containers and verify damage.
- B. Store products in clean, dry area; maintain temperature to NEMA ICS 1.

1.06 ENVIRONMENTAL REQUIREMENTS

- A. Maintain temperature above 32 degrees F and below 104 degrees F during and after installation of products.
- B. Maintain area free of dirt and dust during and after installation of products.

1.07 MAINTENANCE SERVICE

- A. Provide a one (1) year warranty to correct equipment defects from the Date of Substantial Completion.

PART 2 - PRODUCTS

2.01 NETWORK RACKS AND RACK COMPONENTS

A. Wall mount Network Rack and Accessories (NEMA 1)

1. General Specifications
 - a. EIA Compliant 19" Wall mount
 - b. Rack Spaces (Min): 26
 - c. UL weight capacity (Min): 200 lbs.
 - d. Depth (Usable): 20"
 - e. Height (Usable): 45.5"
 - f. Dimensions (Max): 26"W x 22.67"D x 49.38"H
 - g. Frame Construction
 - 1) Material Thickness (Min): 16 Gauge
 - 2) Material Coating: Black Textured Powder Coat
 - h. Rack Rail Construction
 - 1) Material Thickness (Min): 11 Gauge
 - 2) Material Coating: Black Ecoat Finish
 - 3) There shall be cage nut style square mounting holes in universal EIA spacing
 - 4) All rack spaces shall be marked
 - i. Contractor is responsible for verification of compatibility for all rack accessories with vendor. It is intended that all components of rack system be purchased from a single distributor as a single complete package.
 - j. All unused spaces shall be filled with blank plates.
 - k. Network Rack Nuts and Screws Furnished (Min): 50 Each
2. Schedule
 - a. See the Network Rack Layouts and Schedules within the Engineers Drawing Set.
3. Manufacturer/Model
 - a. Rack:
 - 1) Middle Atlantic Products: CWR-26-22PD
 - 2) Hoffman: Equal
 - b. Accessories (Same Manufacturer - Middle Atlantic Products):
 - 1) Rear Rack Rail (1 Pair): CWR-RR18
 - 2) Integrated Fan Kit: CWR-FKIT

- 3) Power Distribution (QTY. 2 per NWP): PDT-2X320
- 4) Front Cable Management: HHCM-1
- 5) Storage Drawer: D2
- 6) Blank Plates: 1U

B. Rackmount Modular Patch Panel

1. General Specifications:
 - a. Provide patch panels in the Network Panel as indicated in the network panel layouts and schedules of the Engineers Drawings.
 - b. Shall have rear mounted faceplates to allow modules to be flush with front of patch panel.
 - c. Shall accept Panduit Mini-Com Modules for UTP, which snap in and out. Mini-Com Modules shall be provided as the following colors as needed.
 - 1) SCADA: Green
 - d. Provide shielded Panduit Mini-Com Modules for the required Circuits per the Cable and Conduit Schedule and the Network Switch Schedule within the Engineers Drawings. Only one side of the shielded circuit shall be grounded to prevent ground loops and additional interference.
 - e. Shall have write-on areas for port and/or panel identification.
 - f. Shall mount to a standard EIA 19" rack.
 - g. Shall include a strain relief bar.
2. Schedule:
 - a. See the Network Rack Layouts and Schedules within the Engineers Drawing Set.
3. Manufacturer/Model:
 - a. Mini-Com Module(s):
 - 1) Shielded:
 - a) Panduit:
 - (1) CJS688TGGR
 - b. Patch Panel(s):
 - 1) Shielded
 - a) Panduit
 - (1) CP24WSBLY
 - (2) CP48WSBLY
 - b) OCC
 - (1) DCC2488/110SIX-S
 - (2) DCC4888/110SIX-S

C. Rackmount Ethernet Switch

1. General Specifications:
 - a. 10/100/1000Base-TX Ports (Min): 24

- b. Gigabit SFP Ports (Min): 4
- c. RAM (Min): 2GB
- d. Switching Capacity (Min): 56 Gbps
- e. Forwarding Rate (Min): 41.66 Mpps
- f. Operating Voltage: 120/230 VAC
- g. Software: Cisco IOS XE
- 2. Additional Requirements:
 - a. Hot Swappable Power Supply
 - 1) Hot-swappable
 - 2) Redundant power supply, Two required per switch.
 - 3) Voltage: 100-240Vac
 - 4) Power:
 - a) 24 Port: 600W
 - b. Fiber Uplink
 - 1) Modular to allow for future growth
 - 2) 4 1G/10G SFP ports
 - 3) SFP Module:
 - a) Connectivity: 10G Single-Mode Fiber
 - b) Link Length: Up to 10km
 - c. Switch Stacking Cable
 - 1) Stack switches to act as a single virtual switch
 - 2) Bandwidth: 160Gbps
 - 3) Cable Length: 1m
 - d. Software license for each switch, 3-years. Number of ports determines license to include
- 3. Schedule:
 - a. See the Network Rack Layouts and Schedules within the Engineers Drawing Set.
- 4. Ethernet Switch Manufacturer/Model:
 - a. Non-POE:
 - 1) Cisco:
 - a) C9200-24T-E

D. Rackmount Ethernet Surge Suppressor

- 1. General Specifications:
 - a. 10/100/1000 Base-TX Ports: 12 PoE enabled
 - b. Max Continuous Voltage: 74V
 - c. Max Continuous Current: 1.5A
 - d. Clamping Voltage: 72V

- e. Dissipation (Pair): 3,000W
 - 2. Schedule:
 - a. See the Network Rack Layouts and Schedules within the Engineers Drawing Set.
 - 3. Manufacturer/Model:
 - a. Ditech DTK-RM12POE
 - b. Prior Approved Equal
- E. Rackmount Uninterruptible Power Supply (UPS)
 - 1. General Specifications:
 - a. Operating Voltage: 120VAC
 - b. Output Voltage: 120VAC
 - c. Output Power (Min): 700 VA
 - d. Outlets (Min): 6
 - e. Reliable, true online, high frequency, double conversion type with batteries for critical type applications in high harmonic and/or noisy electrical installations.
 - f. Expansion Card: INDRELAY-MS
 - 2. Schedule:
 - a. See the Network Rack Layouts and Schedules within the Engineers Drawing Set.
 - 3. Manufacturer/Model:
 - a. Eaton 9PX1500RT
 - b. No Exceptions
- F. Rackmount UPS Maintenance Bypass Switch
 - 1. General Specifications:
 - a. Input Connection: 5-20
 - b. Output Connection: (6) 5-20R
 - c. Voltage: 110-125Vac
 - d. Amperage Rating: 16A
 - e. Wattage: 1920W Max
 - 2. Schedule:
 - a. See the Network Rack Layouts and Schedules within the Engineer's Drawing Set.
 - 3. Manufacturer/Model:
 - a. Eaton EHBPL2000R-PDU1U
 - b. Prior Approved Equal
 - c. No Exceptions
- G. Fiber and CAT 6 Patch Cables
 - 1. General Specifications:
 - a. Provide quantity needed for a complete system.
 - b. Length of each patch cables shall be as needed for each individual application. Excess length of any patch cables shall be minimal.

- c. Color of each patch cable shall match network specific colors for jacks as noted within this section.
- d. Fiber Patch Cables:
 - 1) Provide ends as required on both ends as needed for each device.
 - 2) Provide an additional 5 spare fiber patch cables of each color provided within the project.
- e. Cat6 Copper Patch Cables:
 - 1) Provide snagless type patch cords.
 - 2) Provide an additional 15 spare patch cable of each color for future use.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field measurements are as shown on Drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts conditions.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Do not install products until major construction is complete and building interior is enclosed and heated.
- C. Make connections to devices as shown on Drawings.
- D. Four (4) copies of all material shall be provided with final shipment. These copies shall be in addition to any required by other sections of these specifications.
- E. Provide the necessary time required for field installation and verification of all connections with Electrical Contractor.

3.03 DEMONSTRATION

- A. Provide systems demonstration under provisions of Section 01 75 00.
- B. Demonstrate operation of networking equipment.

3.04 PROGRAMMING

- A. All required PLC programming for Control Panels furnished by the Systems Integrator as specified in Section 40 63 13 - Process Control Panels and Hardware shall be by the Owner and shall not be included in this contract.

END OF SECTION 40 67 13

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SECTION 40 70 01
INSTRUMENTATION GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 REFERENCES

A. Reference Standards:

1. NFPA) 70 - National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies
 - b. NEMA 250 - Enclosures for Electrical Equipment
3. Underwriters Laboratories (UL) - 508 Industrial Control Equipment

1.02 SCOPE

- A. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by the same single-source supplier ("Hardware Systems Integrator") specified in Section 40 61 13 - Process Control System General Requirements unless noted otherwise herein or on engineer's drawings. The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
- B. The Work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.
- C. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs that may result from unauthorized deviations from the Contract Documents.
- D. It shall be the responsibility of the Contractor and supplier to examine all new equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section and the associated instrumentation Sections. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment.

1.03 SUBMITTALS

- A. All submittal requirements stated herein shall be in addition to those outlines Section 01 33 00 - Submittal Procedures.
- B. Shop Drawings:
 - 1. Product technical data including:
 - a. Acknowledgement that products submitted meet requirements of standards referenced.
 - b. Equipment catalog cut sheets.
 - c. Instrument data sheets:
 - 1) ISA S20 or approved equal.
 - 2) Separate data sheet for each instrument type.
 - d. Materials of construction.
 - e. Minimum and maximum flow ranges.
 - f. Pressure loss curves.
 - g. Physical limits of components including temperature and pressure limits.
 - h. Control panel and junction box drawings including system schematic drawings, terminal numbering, component schematic drawings, dimension drawings, layout drawing and nameplate schedule. Where panels, junction boxes and new Owner-furnished equipment is being utilized, the submittal shall include complete schematics showing all proposed equipment, terminals, terminal numbering, wiring, elevations, and details. It shall be the supplier's responsibility to visit the Site and inspect existing and Owner-furnished equipment to prepare complete system drawings for the Project.
 - i. Overall system diagram showing all components, converters, cables, and connectors.
 - 2. Provide a parameter setting summary sheet for each field configurable device.
 - 3. Certifications:
 - a. Documentation verifying that calibration equipment is certified with NIST traceability.
 - b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
 - 1) Certification documentation is required for all equipment for which the specifications require independent agency approval.
- C. Technical data in conformance with Section 01 33 00 - Submittal Procedures and including:
 - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section
 - 2. Junction Box Enclosures
- D. Manufacturer's Instructions

1. Furnish under provisions of Section 01 78 23 - Operation and Maintenance Data.
- E. Manufacturer's Field Service Reports
1. Furnish under provisions of Section 01 78 23 - Operation and Maintenance Data. Reports should cover a minimum of startup, demonstration, and operational instructions.
- F. Operation and Maintenance data in conformance with Section 01 78 23 - Operation and Maintenance Data and including:
1. Panel equipment, junction boxes, field devices and instruments, including "as-built" system schematics. All items requested under Part 2 below should be included in their "as-built" form.
- G. Spare Equipment Lists - Provide a list of recommended spare parts and equipment that is considered essential to the operation of the system. Include list of current prices for each item. These lists may be included with the Operation and Maintenance data submittals.
- H. All submittals shall be searchable documents in PDF file type. They shall be electronically delivered through the platform/method all parties mutually agreed upon. The submittal shall be broken up into sections and bookmarked to allow for easier navigation throughout the submittal.

1.04 CIRCUIT IDENTIFICATION

- A. Each power, control, and signal conductor shall be identified by plastic tags permanently attached to the cable. The tags shall be attached to each cable at each termination and wherever the cable is accessible in junction or pull boxes. Tags shall be marked with printing showing:
1. The circuit number from the cable and conduit schedules.
 2. The terminal number as assigned by the equipment manufacturer.
- B. The cable marking system shall use transparent tape with a white area where the numbering shall be typed using a typewriter or computer, as manufactured by:
1. Raychem
 2. Thomas & Betts
 3. Brady
- C. Contractor supplied "as-built" schematics and wiring diagrams should reflect this described wire identification.

1.05 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 REFER TO THE FOLLOWING PRODUCT SECTIONS

- A. Flow Measurement - See Section 40 71 00
- B. Level Measurement - See Section 40 72 00
- C. Temperature Measurement - See Section 40 74 00
- D. Process Liquid Analytical Measurement - See Section 40 75 00
- E. Process Gas Analytical Measurement - See Section 40 76 00

PART 3 - EXECUTION

3.01 LABELING

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number (if applicable) and item description.
- B. Labels shall be engraved laminated plastic with 1/4" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

3.02 CALIBRATION, ADJUSTING AND TESTING

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

3.03 PROJECT MANAGEMENT

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.
- B. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

3.04 FIELD QUALITY CONTROL

- A. Maintain accurate daily log of all startup activities, calibration functions, and final setpoint adjustments.

- B. Install all instrumentation and equipment as per manufacturer's requirements. Coordinate with Engineer in Field on final instrument locations per manufacturer requirements.
- C. Instrumentation Calibration:
 - 1. Verify and document that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
 - a. Utilize the Instrument Certification Sheet located at the end of this Specification Section (or Engineer approved equivalent) to document on-site calibration checks.
 - 2. Factory furnished calibration certifications are acceptable for the following:
 - a. Flow meters.
 - b. Pressure sensors utilized with annular sleeve.
 - c. Temperature sensors.
 - 3. On-site calibration verification is required for all other instruments, including "smart" transmitters that have been factory calibrated.
 - a. Provide calibration checks at 0 PCT, 25 PCT, 50 PCT, 75 PCT and 100 PCT of span for pressure transmitters and gages.
 - 1) Check for both increasing and decreasing input signals to detect hysteresis.
 - b. In addition to factory calibration certification, temperature sensors and gages shall be checked at a single point for conformance to required accuracy.
 - c. Level transducers/transmitters shall be checked at two points in addition to zero.
 - d. Analytical sensors shall be calibrated in accordance with manufacturer's recommendations.
 - e. Check operation of all switches to verify actuation occurs in accordance with manufacturer's specified accuracy.
 - f. Replace any instrument which cannot be properly adjusted.
 - g. Stroke pneumatic control valves with clean dry air to verify control action, positioner settings, and solenoid functions.
 - 4. Calibration equipment shall be certified by an independent agency with traceability to NIST.
 - a. Certification shall be up-to-date.
 - b. Use of equipment with expired certifications shall not be permitted.
 - 5. Calibration equipment shall be at least three times more accurate as the device being calibrated.
- D. Loop Check-Out Requirements are as Follows:
 - 1. Work closely with the Owner to check control signal generation, transmission, reception and response for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument

connections. Loop check-out work shall verify proper operation of the installed equipment and the Owner's PLC and HMI programming.

- a. Use actual signals where available.
 - b. Closely observe controllers, indicators, transmitters, HMI displays, recorders, alarm and trip units, remote setpoints, ratio systems, and other control components.
 - 1) Verify that readings at all loop components are in agreement.
 - 2) Make corrections as required.
 - a) Following any corrections, retest the loop as before.
2. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.
 3. Check all interlocks to the maximum extent possible.
 4. Utilize the Loop Check-Out Sheet located at the end of this Specification Section (or Engineer approved equivalent) to document on-site calibration checks.
 5. In addition to any other As-Recorded Documents, record all setpoint and calibration changes on all affected Contract Documents and turn over to the Owner.

3.05 FIELD QUALITY CONTROL - INSTALL, START-UP AND WITNESS TESTING

- A. Contractor shall furnish and install raceway and wiring systems for the instrumentation and control system in accordance with manufacturer's requirements and in accordance with Sections 26 05 34 - Conduit. All instrumentation and control system raceways shall be galvanized rigid steel conduit unless specifically indicated otherwise.
- B. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- C. Coordinate installation, start-up and testing scheduling with Owner and Engineer.
- D. Instruct Owner's personnel at the Site on the operation and maintenance of equipment furnished in this Section.
- E. Furnish Owner and Engineer with a written report prepared by Supplier certifying that equipment:
 1. Has been properly installed.
 2. Is in accurate alignment and calibration and is free from undue stress imposed by interconnecting cable/conduit, etc.
 3. Has been operated and witness demonstrated to the Owner under expected conditions and that it operates satisfactorily.

3.06 ON-SITE SERVICES

- A. In addition to other services specified, provide a competent instrumentation engineer or technician to perform the following services:
 - 1. Training – two (2), eight (8) hour days on-Site to train Owner's personnel on operation and maintenance of all equipment furnished under this Section.
- B. All on-Site service shall be at times approved by the Owner.

END OF SECTION 40 70 01

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SECTION 40 71 00
FLOW MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Related sections include but are not limited to:
1. Section 01 33 00 - Submittal Procedures .
 2. Section 01 45 00 - Quality Control .
 3. Section 01 75 00 - Starting and Adjusting .
 4. Section 01 77 00 - Closeout Procedures .
 5. Section 01 78 23 - Operation and Maintenance Data.
 6. Section 26 05 19 - Power and Instrumentation Cable - Less Than 600V .
 7. Section 26 05 34 - Conduit .
 8. Section 26 05 37 - Boxes .
 9. Section 26 05 53 - Identification for Electrical Systems .
 10. Section 40 63 43 - Programmable Logic Controllers .
 11. Section 40 67 13 - Network Racks and Equipment.

1.02 REFERENCES

- A. Reference Standards:
1. National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC)
 2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies
 - b. NEMA 250 - Enclosures for Electrical Equipment
 3. Underwriters Laboratories (UL) - 508 Industrial Control Equipment

1.03 SCOPE

- A. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by the same single-source supplier ("Systems Integrator") specified in Section 40 63 13 unless noted otherwise herein or on engineer's drawings. The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
- B. The Work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.

- C. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs that may result from unauthorized deviations from the Contract Documents.
- D. It shall be the responsibility of the Contractor and supplier to examine all new equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment.

1.04 SUBMITTALS

- A. All submittal requirements stated herein shall be in addition to those outlines in Division 01 of the contract documents.
- B. Technical data in conformance with Section 01 33 00 and including:
 - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section
 - 2. Junction Box Enclosures
- C. Shop Drawings in conformance with Section 01 33 00 and including:
 - 1. Control panel and junction box drawings including system schematic drawings, terminal numbering, component schematic drawings, dimension drawings, layout drawing and nameplate schedule. Where panels, junction boxes and new Owner-furnished equipment is being utilized, the submittal shall include complete schematics showing all proposed equipment, terminals, terminal numbering, wiring, elevations, and details. It shall be the supplier's responsibility to visit the Site and inspect existing and Owner-furnished equipment to prepare complete system drawings for the Project.
 - 2. Overall system diagram showing all components, converters, cables, and connectors.
- D. Manufacturer's Instructions
 - 1. Furnish under provisions of Section 01 78 23.
- E. Manufacturer's Field Service Reports
 - 1. Furnish under provisions of Section 01 78 23. Reports should cover a minimum of start up, demonstration, and operational instructions.

- F. Operation and Maintenance data in conformance with Section 01 78 23 and including:
 - 1. Panel equipment, junction boxes, field devices and instruments, including "as-built" system schematics. All items requested under Item 1.04-B.1 above, should be included in their "as-built" form.
- G. Spare Equipment Lists - Provide a list of recommended spare parts and equipment that is considered essential to the operation of the system. Include list of current prices for each item. These lists may be included with the Operation and Maintenance data submittals.
- H. All submittals shall be searchable documents in PDF file type. They shall be electronically delivered through the platform/method all parties mutually agreed upon. The submittal shall be broken up into sections and bookmarked to allow for easier navigation throughout the submittal.

1.05 TESTING AGENCY CERTIFICATION

- A. All new panels and control system junction boxes furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment" or Underwriter's Laboratories (UL) Standard 698 - "Industrial Control Equipment for Use in Hazardous (Classified) Locations".
- B. Each panel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard UL 508A or UL 698A.

1.06 CIRCUIT IDENTIFICATION

- A. Each power, control, and signal conductor shall be identified by plastic tags permanently attached to the cable. The tags shall be attached to each cable at each termination and wherever the cable is accessible in junction or pull boxes. Tags shall be marked with printing showing:
 - 1. The circuit number from the cable and conduit schedules.
 - 2. The terminal number as assigned by the equipment manufacturer.
- B. The cable marking system shall use transparent tape with a white area where the numbering shall be typed using a typewriter or computer, as manufactured by:
 - 1. Raychem
 - 2. Thomas & Betts
 - 3. Brady
- C. Contractor supplied "as-built" schematics and wiring diagrams should reflect this described wire identification.

1.07 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 ELECTROMAGNETIC FLOWMETER

A. General Specifications

1. The flow meter shall be a flanged sensor (by application and instrument schedule) and transmitter which may be mounted integral (compact) to the sensor or remotely.
2. The flow metering system shall be three-stage microprocessor controller and possess a non-volatile memory to store the sensor calibration and transmitter setup information.
3. The electronics shall be interchangeable for meters sizes 1" - 90".
4. The sensor shall be the proper size to measure the design flow rate of the piping and measure bi-directional flow as a standard
5. The sensor shall consist of a stainless steel flow tube with ANSI B16.5, AWWA C207 carbon steel, or stainless steel flanges.
6. The flanges shall be Class 150 for diameters less than 24" and AWWA Class D for diameters larger than 28" (listed by the application and instrument schedule).
7. Flow Meter Specifications by size
 - a. Diameter: 1" - 6"
 - 1) Fixed or rotating lap joint flanges
 - 2) Hard Rubber or Polyurethane Liner
 - 3) 0.5% min reference accuracy
 - b. Diameter: 8" - 12"
 - 1) Fixed or rotating lap joint flanges
 - 2) Hard rubber or Polyurethane liner
 - 3) 0.25% min reference accuracy
8. The sensor tube shall be in accordance with NSF-61 based upon the size of the flow meter and the process media conditions.

9. The sensor shall house minimum of two (2) measuring electrodes and a grounding ring. The electrodes shall be bullet-nosed shaped and Alloy C22 unless otherwise noted on instrument schedule.
10. The sensor liner and electrode material shall be validated to be compatible with the process fluid. All fluids require a minimum conductivity of 5 μ S/cm (20 μ S/cm for deionized water).
11. In the event of industrial treatment or corrosive/brackish environments, the flow sensor shall be painted and certified according to ISO-12944 corrosion class. Third party modification or sensor preparations will not be accepted without type test documentation to support the exposure conditions, depth, and duration of resistance.
12. Stainless Steel Tag
13. Grounding rings required on all Flow Meters
14. Transmitter Specifications
 - a. The transmitter shall have a local operating interface to allow local programming that can be operated through the enclosure window without opening the electrical enclosure
 - b. The transmitter shall allow local programming that can be operated through the enclosure window without opening the electrical enclosure
 - c. Diameter: 1"- 90"
 - 1) Input Voltage: 100-240 VAC
 - 2) Signal Output: Two (2) Wire 4-20 mA HART
 - 3) Display shall indicate simultaneous flow rate and total flow with 3 totalizers (forward, reverse and net total) and user-selectable engineering units, readout of diagnostic error messages, and support 12 standard languages.
 - 4) Transmitter shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected with a minimum requirement of dual passwords according to data sensitivity.
 - 5) Transmitter output(s) shall be integral to the magnetic flowmeter transmitter electronics; using an external third party signal converter is unacceptable.
 - 6) There shall be no limitation of transmitter operational capability or diagnostic dependency between integral and compact mounting orientation.
 - 7) Transmitter shall retain all setup parameters and accumulated measurements internally in non-volatile memory in the event of power failure. The memory unit shall be transferrable from a

damaged unit or used for a duplicate device with no loss of device parameters or data stored.

- 8) Transmitter shall be protected against voltage spikes from the power source with internal transient protection. Power consumption shall be no more than 16 VA, independent of meter size.

B. Cable Specifications

1. Cable requirements for the remote transmitters shall be coordinated with the electrical specifications and drawings. Cable requirements for all flow meters shall be the responsibility of the Contractor and manufacturer. Contractor shall verify lengths for manufacturer prior to ordering flow meters.
2. Cable runs shall be no longer than 650 ft between the transmitter and the point of signal interception within the controls system.
3. Cables for flowtubes and transmitters separated by distances greater than 100 feet shall be of Beldon 8762 twisted shielded pair and coil shall be of beldon 8720 twisted shielded pair.

C. Schedule

1. Flow Meter(s) shall be furnished and installed for the following application(s):
 - a. GPI-FE1/FIT1

D. Manufacturer/Model

1. Endress+Hauser W 500 (C1D1 Rated)
2. Prior Approved Equal

2.02 FLO-DAR SYSTEM

A. Flow Logger

1. The flow logger shall be a battery-powered data logger housed in a sealed NEMA 6P/IP68 rated PC/ABS structural foam enclosure.
2. The logger shall provide one, two or four sensor ports, one communications port, and one auxiliary port (for external power or connection to a sampler) placed on the vertical sides of the logger.
 - a. Model FL901 shall be equipped with 1 sensor port and support 1 flow equation.
 - b. Model FL902 shall be equipped with 2 sensor ports and support up to 2 flow equations, one for each port.
3. The sensor ports shall be self-detecting for FLO-DAR, FLO-DAR Surge Velocity Sensor, Hach Submerged AV sensor with AV9000 module, and Hach US900X.

4. Power requirements shall be 8 to 18 VDC from batteries or external power source, 2.5W maximum.
 - a. Four 6V alkaline batteries shall be provided with the unit. The logger shall also be capable of operating on two 6V alkaline batteries. The battery compartment shall be sealed with an o-ring for additional moisture barrier.
 - b. If available, power from an external source (either AC or DC) can be fed to the controller.
 - 1) External power source options include solar panel with deep cycle battery, AC (requires AC to DC adaptor cable), and long-life alkaline battery.
 - 2) When external power is supplied, the logger shall be capable of power switching, i.e. drawing first from the external power source and using the back-up batteries only in the event of low power or power fail to optimize the life of the alkaline batteries installed in the base of the logger.
5. The logger shall be capable of operating in temperatures ranging -18C to 60C (0F to 140F) at 95% RH.
6. The logger shall have an LED indicator for operating/programming status visible on the top surface of the logger.
7. The logger shall be able to communicate to a computer locally via USB or RS232 connection (Baud rates: 9600, 19200, 38400, 38400, 57600, 115200)
8. The logger shall have remote communication options via CDMA2000 1xRTT or GSM/GPRS.
9. The antenna options available shall include half-wave, mini-wing, traffic-rated in-road/burial, and traffic- rated manhole lid antennas.
10. Communication protocols shall include: Modbus RTU, Modbus ASCII, Mobile-Terminated SMS, Mobile- Originated SMS, and TCP/IP.
11. The logger shall have maximum of 16 channel alarms with high/high, high, low, low/low options. Additionally system alarms include low battery, low RTC battery, low slate memory and slate memory full.
 - a. In the event of an alarm condition, the following alarm actions shall be available: start the sampler, change the log interval, and / or change the call interval; the logger, server or both shall be able to send an email or a text message (SMS) up to five addresses or cell phone numbers.
12. The logger shall be capable of secondary logging intervals for dynamic logging where the logging interval changes upon a user defined alarm trigger.
 - a. Primary and secondary logging intervals shall be 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30 or 60 minutes.
13. Data shall be stored in non-volatile flash memory and be retained when power is removed:

- a. Event Log: 1,000 events.
 - b. Sampler History: 2,000 sample events maximum.
 - c. Datalog: 325,000 data points; 1128 days for 3 channels at 15 minute log intervals.
- 14. Timebase accuracy of the Flow Logger shall be 0.002% synchronized every 24 hours with server software and modem.
- 15. Certifications:
 - a. Logger: CE/CSA
 - b. Optional AC power supply: UL/CSA/CE
 - c. Modems: FCC, NB, IC others may be available—contact manufacturer for more information
- 16. Software
 - a. Provide owner with desktop software for Windows for data management and instrument communications per manufacturer requirements. Software shall be FSDATA.

B. Flow Sensor

- 1. The sensor shall consist of three transducers housed in a polystyrene IP 68 rating watertight enclosure.
- 2. The sensor shall be of the non-contact type and be mounted above the flow surface.
- 3. The sensor shall be capable of operating at temperatures ranging from 14° F to 122° F (-10° to 50° C)
- 4. Power for the sensor shall be supplied by the FL900 Flow Logger.
- 5. The three transducers shall be Digital Doppler radar for surface velocity, an ultrasonic pulse echo for fluid level, and a Piezo-resistive pressure measurement for surcharge level.
- 6. The radar beam shall transmit signals, which interact with the fluid and reflect back at a different frequency. These reflected signals shall be compared with the transmitted frequency, resulting in a frequency shift. The frequency shift shall provide an accurate measurement of the flow velocity. The non-contact sensor shall be able to measure surface velocity and make real time adjustments to convert surface velocity to average velocity via an algorithm that considers the fluid level and the size of the pipe.
 - a. Velocity Measurement
 - 1) Method: Radar
 - 2) Range: 0.75 to 20 ft/s (0.23 m/s to 6.10 m/s)
 - 3) Accuracy: ±0.5%; ±0.1 ft/s (±0.03 m/s)
- 7. Fluid level shall be measured with an ultrasonic pulse echo transceiver by transmitting a sound wave to the fluid surface.
 - a. Level Measurement
 - 1) Method: Ultrasonic

- 2) Operating Range from Flo-Dar Housing to liquid: 0 to 60 inches (0 to 152.4 cm)
 - 3) Optional Extended Level Operating Range from Transducer Face to Liquid: 0 to 20 ft (0 to 6.1 m) with 17" (43.2 cm) deadband, temperature compensated
 - 4) Accuracy: $\pm 1\%$, ± 0.1 inches (± 0.25 cm)
8. The sensor shall accurately measure flows in circular and rectangular channels down to flow depths of $\frac{1}{4}$ in.
 9. Flow shall be calculated based on the Continuity Equation ($Q=V \times A$), where Q = flow, V = average velocity and A =area.
 - a. The accuracy shall be typical $\pm 5\%$ of the reading where flow is in a channel with uniform flow conditions and is not surcharged, $\pm 1\%$ full scale maximum.
 10. A Piezo-resistive pressure sensor shall be used to measure the level of fluid above the sensor if a surcharge condition occurs.
 - a. Surcharge Velocity Measurement
 - 1) Method: Electromagnetic
 - 2) Range: ± 16 ft/s (± 4.8 m/s)
 - 3) Accuracy: ± 0.15 ft/sec or 4% of reading, whichever is greater
 - 4) Zero Stability: $> \pm 0.05$ ft/sec
 11. Certifications:
 - a. FCC Rules Part 15.245: FCC ID: VIC-FLODAR24
 - b. Industry Canada Spec. RSS210. V7: IC No.: 6149A-FLODAR24

C. Sensor Cable

1. The standard sensor cable shall be abrasive resistant polyurethane jacket with waterproof connectors.
2. The connectors shall allow for each connection of the monitor unit to the FLO-DAR sensor. The standard flow meter shall be provided with 30 feet of cable. Additional sensor cable assemblies, of various lengths, shall be available as field-installable options.
3. The additional sensor cable assemblies shall allow the user to extend the distance between the monitor unit and FLO-DAR sensor up to 1,000 feet.
4. A junction box should be available as an accessory to allow sensor cable to be easily run through conduit.
5. There shall be an air-tube enclosed in the sensor cable to vent moisture to a desiccant canister to protect the electronics of the sensor from moisture and damage.

- a. A Teflon® hydrophobic filter shall be installed in the desiccant canister to prevent liquid from entering the vent tube.

D. Mounting Hardware

1. Logger

- a. The logger shall be compatible with hardware capable of mounting to a fixed post or railing, attaching to a ladder rung, or suspended using cables or bars bolted directly inside a manhole.

2. Sensor

- a. The sensor shall be mounted directly above the flow by using a permanent mount.
 - 1) The permanent mount shall be of stainless steel material suitable for manhole applications and consist of a sensor mount frame, wall mount frame, wall mount bracket, two space bars and clamps which can be bolted directly inside a manhole.
 - 2) The sensor mounts shall be designed for easy insertion and retraction of the sensor without entering the manhole with use of the optional retrieval pole and hook assembly.
- b. A sensor laser alignment tool shall be available as an option. The laser alignment tool is recommended to properly align sensor during installation.

E. Warranty

- 1. All equipment is covered by a one-year factory warranty from the date of shipment.

F. Schedule

- 1. Flo-Dar System shall be furnished and installed for the following application(s):
 - a. BPI-FE1 / FIT1
 - b. DME-FE1 / FIT1

PART 3 - EXECUTION

3.01 LABELING

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number (if applicable) and item description.
- B. Labels shall be engraved laminated plastic with 1/4" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

3.02 CALIBRATION, ADJUSTING AND TESTING

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

3.03 PROJECT MANAGEMENT

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.
- B. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

3.04 FIELD QUALITY CONTROL - INSTALL, START-UP AND WITNESS TESTING

- A. Contractor shall furnish and install raceway and wiring systems for the instrumentation and control system in accordance with manufacturer's requirements and in accordance with Sections 26 05 34. All instrumentation and control system raceways shall be galvanized rigid steel conduit unless specifically indicated otherwise.
- B. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- C. Coordinate installation, start-up and testing scheduling with Owner and Engineer.
- D. Instruct Owner's personnel at the Site on the operation and maintenance of equipment furnished in this Section.
- E. Furnish Owner and Engineer with a written report prepared by Supplier certifying that equipment:
 - 1. Has been properly installed.
 - 2. Is in accurate alignment and calibration and is free from undue stress imposed by interconnecting cable/conduit, etc.
 - 3. Has been operated and witness demonstrated to the Owner under expected conditions and that it operates satisfactorily.

3.05 ON-SITE SERVICES

- A. In addition to other services specified, provide a competent instrumentation engineer or technician to perform the following services:
 - 1. Training – one (1), eight (8) hour days on-Site to train Owner's personnel on:
 - a. Operation and maintenance of all equipment furnished under this Section.

- B. All on-Site service shall be at times approved by the Owner.

END OF SECTION 40 71 00

SECTION 40 72 00
LEVEL MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Related sections include but are not limited to:
1. Section 01 33 00 - Submittal Procedures
 2. Section 01 45 00 - Quality Control
 3. Section 01 75 00 - Starting and Adjusting
 4. Section 01 77 00 - Closeout Procedures
 5. Section 01 78 23 - Operation and Maintenance Data
 6. Section 26 05 19 - Power and Instrumentation Cable - Less Than 600V
 7. Section 26 05 34 - Conduit
 8. Section 26 05 37 - Boxes
 9. Section 26 05 53 - Identification for Electrical Systems
 10. Section 40 63 14 - Junction Boxes and Control Stations
 11. Section 40 63 43 - Programmable Logic Controllers

1.02 REFERENCES

- A. Reference Standards:
1. National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC)
 2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies
 - b. NEMA 250 - Enclosures for Electrical Equipment
 3. Underwriters Laboratories (UL) - 508 Industrial Control Equipment

1.03 SCOPE

- A. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by the same single-source supplier ("Systems Integrator") specified in Section 40 63 13 unless noted otherwise herein or on engineer's drawings. The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
- B. The Work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.

- C. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs that may result from unauthorized deviations from the Contract Documents.
- D. It shall be the responsibility of the Contractor and supplier to examine all new equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment.

1.04 SUBMITTALS

- A. All submittal requirements stated herein shall be in addition to those outlines in Division 01 of the contract documents.
- B. Technical data in conformance with Section 01 33 00 and including:
 - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section
 - 2. Junction Box Enclosures
- C. Shop Drawings in conformance with Section 01 33 00 and including:
 - 1. Control panel and junction box drawings including system schematic drawings, terminal numbering, component schematic drawings, dimension drawings, layout drawing and nameplate schedule. Where panels, junction boxes and new Owner-furnished equipment is being utilized, the submittal shall include complete schematics showing all proposed equipment, terminals, terminal numbering, wiring, elevations, and details. It shall be the supplier's responsibility to visit the Site and inspect existing and Owner-furnished equipment to prepare complete system drawings for the Project.
 - 2. Overall system diagram showing all components, converters, cables, and connectors.
- D. Manufacturer's Instructions
 - 1. Furnish under provisions of Section 01 78 23.
- E. Manufacturer's Field Service Reports
 - 1. Furnish under provisions of Section 01 78 23. Reports should cover a minimum of start up, demonstration, and operational instructions.

- F. Operation and Maintenance data in conformance with Section 01 78 23 and including:
 - 1. Panel equipment, junction boxes, field devices and instruments, including "as-built" system schematics. All items requested under Item 1.04-B.1 above, should be included in their "as-built" form.
- G. Spare Equipment Lists - Provide a list of recommended spare parts and equipment that is considered essential to the operation of the system. Include list of current prices for each item. These lists may be included with the Operation and Maintenance data submittals.
- H. All submittals shall be searchable documents in PDF file type. They shall be electronically delivered through the platform/method all parties mutually agreed upon. The submittal shall be broken up into sections and bookmarked to allow for easier navigation throughout the submittal.

1.05 TESTING AGENCY CERTIFICATION

- A. All new panels and control system junction boxes furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment" or Underwriter's Laboratories (UL) Standard 698 - "Industrial Control Equipment for Use in Hazardous (Classified) Locations".
- B. Each panel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard UL 508A or UL 698A.

1.06 CIRCUIT IDENTIFICATION

- A. Each power, control, and signal conductor shall be identified by plastic tags permanently attached to the cable. The tags shall be attached to each cable at each termination and wherever the cable is accessible in junction or pull boxes. Tags shall be marked with printing showing:
 - 1. The circuit number from the cable and conduit schedules.
 - 2. The terminal number as assigned by the equipment manufacturer.
- B. The cable marking system shall use transparent tape with a white area where the numbering shall be typed using a typewriter or computer, as manufactured by:
 - 1. Raychem
 - 2. Thomas & Betts
 - 3. Brady
- C. Contractor supplied "as-built" schematics and wiring diagrams should reflect this described wire identification.

1.07 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 RADAR LEVEL TRANSMITTER

- A. General Specifications
 - 1. Range (Configurable): 0-230
 - 2. Accuracy (Minimum): ± 0.08 "
 - 3. Pulse Rate: 2 per second
 - 4. Beam Width (Application Dependent): 4.5-22 degree
 - 5. Dead Band (Maximum): 1.0 ft
 - 6. Display Units: Feet
 - 7. Input Voltage: 12-35 VDC Loop Powered
 - 8. Signal Output: Two (2) Wire 4-20 mA HART
 - 9. Display: 4-Line with Push Buttons
 - 10. Temperature Range: -40 to 302 degrees F
 - 11. Enclosure Rating: NEMA 4X, IP66/IP67
 - 12. Enclosure Material:
 - a. Aluminum
 - 13. Transducer Coating: PTFE
 - 14. Process Connections (Vary Based on Installation)
 - a. Mounted on manufacturer provided L-Bracket per drawings.
 - 15. Conduit Connection: $\frac{1}{2}$ inch NPT
 - 16. Stainless Steel Tag
 - 17. Wireless Connectivity: Bluetooth (If Available)
- B. Radar level transmitters shall be mounted as shown in the Electrical Drawing's Details.
- C. Schedule
 - 1. As shown on drawings.
- D. Spares
 - 1. Provide one (1) spare level transmitter of each process connection size.
- E. Manufacturer/Model

1. Endress+Hauser FMR51/FMR52
2. Rosemount 5408
3. Prior Approved Equal

2.02 SUBMERSIBLE LEVEL TRANSDUCER - PRESSURE

A. General Specifications

1. Calibrated Span as required per application
2. Accuracy: $\pm 0.25\%$ Full Calibrated Span
3. Long-term stability: $\pm 0.1\%$ of Upper Range Limit
4. 316 SS Construction
5. Input Voltage: 14-36 VDC loop powered
6. Signal Output: Two (2) Wire 4-20mA HART
7. Electrical/Process Temperature Range: -4-140°F
8. Vented gage system with Aneroid Bellows for protection from elements
9. Full Lightning Protection
10. Process Connection
 - a. Cable Mounting Screws
11. Electrical Connection: Molded Cable Seal
12. Polyurethane cable: Length as need per application
13. Capable of sensing the PSI range as indicated per the IO Schedule
14. IP 68 & NEMA 6P Protection Ratings
15. The sensor shall be aluminum oxide with FKM Viton seal
16. Cable shall be of material polyethylene (PE), polyurethane (PUR) or fluorinated ethylene propylene (FEP) over shielded copper twisted pair and vent tube
17. Process Temperature Range: 14 to 158 °F
18. Stainless Steel Tag

B. Accessories

1. For wetwell applications, attach cable and transducer to Anchor Kit provided for the floats
2. Cable hanger shall be used to suspend cable and sensor in basin
 - a. Esterline Pressure Systems 12-90-0931
 - b. Prior Approved Equal
3. Stainless Steel Conduit
 - a. 3' in length
 - b. 1/2" threaded conduit
 - c. 316 stainless steel
 - d. Welded ring at top for cable attachment
4. Stainless Steel Wire Rope
 - a. 1/8" diameter
 - b. Aircraft grade
 - c. Length as needed

C. Schedule

1. Submersible Level (Pressure) Transducers shall be furnished and installed for the following application(s):
 - a. As required in other Specification Sections and within Drawings.

D. Spares

1. Provide one (1) spare Submersible Level Transmitter.

E. Manufacturer/Model

1. KPSI Series 750
2. Prior Approved Equal

2.03 FLOAT SWITCH

A. Float General Specifications

1. Dual high/low or high/high level switch
2. Polypropylene with encapsulated mechanical tilt switch
3. Contact Ratings
 - a. SPDT
 - b. 3 amps
 - c. 120VAC
4. Operating Nominal Differential Minimum: 3.5 inches
5. Manufacturer supplied cord of sufficient length to reach termination point indicated on plans

B. Anchor Kit

1. General Specifications
 - a. 15 lb. vinyl coated cast iron anchor
 - b. 1/8" 316 SS, vinyl coated cable
 - c. Stainless steel bracket and hardware
2. Schedule
 - a. Anchor Kits shall be furnished and installed for the following application(s):
 - 1) As required for each application.
3. Manufacturer/Model
 - a. Anchor Scientific WRW
 - b. Prior Approved Equal

C. Schedule

1. Float switches shall be furnished and installed for the following application(s):
 - a. As shown on drawings.

- D. Spares
 - 1. Provide one (1) spare float switch.
- E. Manufacturer/Model
 - 1. Anchor Scientific Model: GSINONC
 - 2. Prior Approved Equal

2.04 FLOOD SWITCH

- A. General Specifications
 - 1. Electrical
 - a. Two wire termination
 - b. SPST contacts
 - c. 120VAC 20VA rated
 - 2. Nominal Operating Differential: 1-3/8"
 - 3. Manufacturer supplied extra flexible cord of sufficient length to reach junction box as indicated on plans with waterproof connection to sensor
- B. Schedule
 - 1. As shown within Drawings.
- C. Manufacturer/Model
 - 1. Gem Sensors LS-270 Series – P/N: 43760
 - 2. Prior Approved Equal

PART 3 - EXECUTION

3.01 LABELING

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number (if applicable) and item description.
- B. Labels shall be engraved laminated plastic with 1/4" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

3.02 CALIBRATION, ADJUSTING AND TESTING

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

3.03 PROJECT MANAGEMENT

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.

- B. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

3.04 FIELD QUALITY CONTROL - INSTALL, START-UP AND WITNESS TESTING

- A. Contractor shall furnish and install raceway and wiring systems for the instrumentation and control system in accordance with manufacturer's requirements and in accordance with Sections 26 05 34. All instrumentation and control system raceways shall be galvanized rigid steel conduit unless specifically indicated otherwise.
- B. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- C. Coordinate installation, start-up and testing scheduling with Owner and Engineer.
- D. Instruct Owner's personnel at the Site on the operation and maintenance of equipment furnished in this Section.
- E. Furnish Owner and Engineer with a written report prepared by Supplier certifying that equipment:
 - 1. Has been properly installed.
 - 2. Is in accurate alignment and calibration and is free from undue stress imposed by interconnecting cable/conduit, etc.
 - 3. Has been operated and witness demonstrated to the Owner under expected conditions and that it operates satisfactorily.

3.05 ON-SITE SERVICES

- A. In addition to other services specified, provide a competent instrumentation engineer or technician to perform the following services:
 - 1. Training – one (1), eight (8) hour day on-Site to train Owner's personnel on:
 - a. Operation and maintenance of all equipment furnished under this Section.
- B. All on-Site service shall be at times approved by the Owner.

END OF SECTION 40 72 00

SECTION 40 73 00
PRESSURE, STRAIN, AND FORCE MEASUREMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Related sections include but are not limited to:
1. Section 01 33 00 - Submittal Procedures
 2. Section 01 45 00 - Quality Control
 3. Section 01 75 00 - Starting and Adjusting
 4. Section 01 77 00 - Closeout Procedures
 5. Section 01 78 23 - Operation and Maintenance Data
 6. Section 26 05 19 - Power and Instrumentation Cable - Less Than 600V
 7. Section 26 05 34 - Conduit
 8. Section 26 05 37 - Boxes
 9. Section 26 05 53 - Identification for Electrical Systems
 10. Section 40 63 14 - Junction Boxes and Control Stations
 11. Section 40 63 43 - Programmable Logic Controllers

1.02 REFERENCES

- A. Reference Standards:
1. National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC)
 2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies
 - b. NEMA 250 - Enclosures for Electrical Equipment
 3. Underwriters Laboratories (UL) - 508 Industrial Control Equipment

1.03 SCOPE

- A. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by the same single-source supplier ("Systems Integrator") specified in Section 40 63 13 unless noted otherwise herein or on engineer's drawings. The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
- B. The Work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.

- C. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs that may result from unauthorized deviations from the Contract Documents.
- D. It shall be the responsibility of the Contractor and supplier to examine all new equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment.

1.04 SUBMITTALS

- A. All submittal requirements stated herein shall be in addition to those outlines in Division 01 of the contract documents.
- B. Technical data in conformance with Section 01 33 00 and including:
 - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section
 - 2. Junction Box Enclosures
- C. Shop Drawings in conformance with Section 01 33 00 and including:
 - 1. Control panel and junction box drawings including system schematic drawings, terminal numbering, component schematic drawings, dimension drawings, layout drawing and nameplate schedule. Where panels, junction boxes and new Owner-furnished equipment is being utilized, the submittal shall include complete schematics showing all proposed equipment, terminals, terminal numbering, wiring, elevations, and details. It shall be the supplier's responsibility to visit the Site and inspect existing and Owner-furnished equipment to prepare complete system drawings for the Project.
 - 2. Overall system diagram showing all components, converters, cables, and connectors.
- D. Manufacturer's Instructions
 - 1. Furnish under provisions of Section 01 78 23.
- E. Manufacturer's Field Service Reports
 - 1. Furnish under provisions of Section 01 78 23. Reports should cover a minimum of start up, demonstration, and operational instructions.

- F. Operation and Maintenance data in conformance with Section 01 78 23 and including:
 - 1. Panel equipment, junction boxes, field devices and instruments, including "as-built" system schematics. All items requested under Item 1.04-B.1 above, should be included in their "as-built" form.
- G. Spare Equipment Lists - Provide a list of recommended spare parts and equipment that is considered essential to the operation of the system. Include list of current prices for each item. These lists may be included with the Operation and Maintenance data submittals.
- H. All submittals shall be searchable documents in PDF file type. They shall be electronically delivered through the platform/method all parties mutually agreed upon. The submittal shall be broken up into sections and bookmarked to allow for easier navigation throughout the submittal.

1.05 TESTING AGENCY CERTIFICATION

- A. All new panels and control system junction boxes furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment" or Underwriter's Laboratories (UL) Standard 698 - "Industrial Control Equipment for Use in Hazardous (Classified) Locations".
- B. Each panel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard UL 508A or UL 698A.

1.06 CIRCUIT IDENTIFICATION

- A. Each power, control, and signal conductor shall be identified by plastic tags permanently attached to the cable. The tags shall be attached to each cable at each termination and wherever the cable is accessible in junction or pull boxes. Tags shall be marked with printing showing:
 - 1. The circuit number from the cable and conduit schedules.
 - 2. The terminal number as assigned by the equipment manufacturer.
- B. The cable marking system shall use transparent tape with a white area where the numbering shall be typed using a typewriter or computer, as manufactured by:
 - 1. Raychem
 - 2. Thomas & Betts
 - 3. Brady
- C. Contractor supplied "as-built" schematics and wiring diagrams should reflect this described wire identification.

1.07 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 PRESSURE SWITCH - STANDARD OR DIFFERENTIAL

A. Switch General Specifications

- 1. Type: Diaphragm Actuated
- 2. Setpoint Adjustment: Field Adjustable
- 3. Deadband Adjustment: Field Adjustable
- 4. Contact Rating: General Purpose DPDT, 10A at 120VAC
- 5. Enclosure Rating: Nema 4X
- 6. Over-Range / Burst Pressure: >Max Process Line Pressure
- 7. Connection Port Material: Stainless Steel. Contractor to verify compatibility with required liquids
- 8. Wetted Parts: Teflon-Coated or Viton
- 9. Conduit Connection: 3/4" NPT
- 10. Process Connection: 1/2" NPT

B. Additional Features/Options

- 1. Stainless Steel Tag
- 2. Chained Cover
- 3. Switch Mounted Indicator Light(s)

C. Accessories (As required per application)

- 1. Snubber
 - a. Size and Pressure: Compatible w/ switch served
 - b. Manufacturer/Model
 - 1) Ashcroft "Pulsation Dampers"
 - 2) Approved Equal
- 2. Diaphragm Seal
 - a. 1/2" NPT Thread-attached type
 - b. Removable diaphragm
 - c. Compatible with the process fluid
 - d. Diaphragm seal along w/ switch shall be factory assembled, filled with a suitable fluid, and calibrated as a unit

- e. Lower housing shall include a tapped and plugged 1/4" NPT flushing connection
- D. Schedule:
 - 1. See instrumentation schedule in the E drawings.
- E. Manufacturer/Model:
 - 1. Ashcroft B-Series Type 400

PART 3 - EXECUTION

3.01 LABELING

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number (if applicable) and item description.
- B. Labels shall be engraved laminated plastic with 1/4" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

3.02 CALIBRATION, ADJUSTING AND TESTING

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

3.03 PROJECT MANAGEMENT

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.
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3.04 FIELD QUALITY CONTROL - INSTALL, START-UP AND WITNESS TESTING

- A. Contractor shall furnish and install raceway and wiring systems for the instrumentation and control system in accordance with manufacturer's requirements and in accordance with Sections 26 05 34. All instrumentation and control system raceways shall be galvanized rigid steel conduit unless specifically indicated otherwise.
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- C. Coordinate installation, start-up and testing scheduling with Owner and Engineer.

- D. Instruct Owner's personnel at the Site on the operation and maintenance of equipment furnished in this Section.
- E. Furnish Owner and Engineer with a written report prepared by Supplier certifying that equipment:
 - 1. Has been properly installed.
 - 2. Is in accurate alignment and calibration and is free from undue stress imposed by interconnecting cable/conduit, etc.
 - 3. Has been operated and witness demonstrated to the Owner under expected conditions and that it operates satisfactorily.

3.05 ON-SITE SERVICES

- A. In addition to other services specified, provide a competent instrumentation engineer or technician to perform the following services:
 - 1. Training – two (2), eight (8) hour days on-Site to train Owner's personnel on:
 - a. Operation and maintenance of all equipment furnished under this Section.
- B. All on-Site service shall be at times approved by the Owner.

END OF SECTION 40 73 00

SECTION 40 75 00
PROCESS LIQUID ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.01 REFERENCES

A. Reference Standards:

1. National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies
 - b. NEMA 250 - Enclosures for Electrical Equipment
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- A. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by the same single-source supplier ("Systems Integrator") specified in Section 40 63 13 unless noted otherwise herein or on engineer's drawings. The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
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- G. Spare Equipment Lists - Provide a list of recommended spare parts and equipment that is considered essential to the operation of the system. Include list of current prices for each item. These lists may be included with the Operation and Maintenance data submittals.
- H. All submittals shall be searchable documents in PDF file type. They shall be electronically delivered through the platform/method all parties mutually agreed upon. The submittal shall be broken up into sections and bookmarked to allow for easier navigation throughout the submittal.

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- B. Each panel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard UL 508A or UL 698A.

1.05 CIRCUIT IDENTIFICATION

- A. Each power, control, and signal conductor shall be identified by plastic tags permanently attached to the cable. The tags shall be attached to each cable at each termination and wherever the cable is accessible in junction or pull boxes. Tags shall be marked with printing showing:
 - 1. The circuit number from the cable and conduit schedules.
 - 2. The terminal number as assigned by the equipment manufacturer.
- B. The cable marking system shall use transparent tape with a white area where the numbering shall be typed using a typewriter or computer, as manufactured by:
 - 1. Raychem
 - 2. Thomas & Betts
 - 3. Brady
- C. Contractor supplied "as-built" schematics and wiring diagrams should reflect this described wire identification.

1.06 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 ANALYTICAL TRANSMITTER

One Required for each location used in conjunction with pH, Dissolved Oxygen Sensors, and Total Suspended Solids.

1. Shall be a multi-parameter controller with up to eight measuring channels based on digital Memosens technology.
2. Programmed computations and features resident in nonvolatile memory.
3. Transmitter firmware shall be upgradable in the field by the user or a factory technician, without removing the transmitter from service.
4. Transmitter shall be available in a Nema 4X field housing with integral display or a DIN rail-mount version for cabinet mounting with remote display.
5. Digital communications provides for plug and play for all sensor configurations.
6. Shall be capable of modification for new or extended functions by use of modular components that are easily retrofitted in the field without the aid of tools, and without the need to power down the transmitter or re-boot the system.
7. Simple wiring for all types of digital Memosens sensors plus an option for a M12 sensor connector.
8. Digital communications protocols available shall include the following without using an external converter. Digital communication shall be available as a native output from the sampler. Use of an external third-party signal converter is not acceptable.
 - a. 4-20mA, HART.
9. Transmitter shall have an option for relay outputs, analog inputs, and discrete input/outputs.
10. Manufacturer/Model
 - a. Endress+Hauser Liquiline CM444
 - b. Hach SC4500
 - c. Prior Approved Equal

2.02 DISSOLVED OXYGEN SENSOR/TRANSMITTER

- A. Optical fluorescence technology with minimum maintenance and maximum availability.
- B. Shall incorporate digital Memosens technology with calibration saved in sensor and a high degree of EMC protection.
- C. Simple single-point calibration in air, air-saturated water or in medium shall be possible.
- D. Extended maintenance intervals and a high degree of long-term stability; intelligent self-monitoring shall guarantee reliable measure values.
- E. Fixed, waterproof cable connection at the sensor with up to 330 feet (100 meters) length between the sensor and transmitter.
- F. Sensor General Specifications:

1. Measurement Range: 0-20 mg/l, 0-200 %SAT, 0-400 hPa
2. Repeatability: $\pm 0.5\%$ of measuring range end
3. Max Measured Error: 0.01 mg/l or $\pm 1\%$ of measured value (< 12 mg/l) $\pm 2\%$ of measured value (from 12 to 20 mg/l)
4. Response time (t90): 60 sec.
5. Sensor cap lifetime: > 2 years (under reference operating conditions, protected against direct sunlight)
6. Temperature Sensor: NTC temperature sensor, 0-50°C (32-122°F)

G. Accessories

1. Stainless Steel Tag
2. Installation:
 - a. Channel Immersion
Flexdip CYA112 Assembly
 - 1) Type: Immersion Pipe
 - 2) Material: Stainless Steel
 - 3) Length: 1800mm
 - 4) Connection Angle: Straight
 - 5) Sensor Adapter: 3/4" NPT
 - 6) Accessories:
 - a) Quick Fastener for Sensor

H. Schedule:

1. Dissolved Oxygen sensors shall be furnished and installed for the following application(s):
 - a. As shown on drawings.

I. Sensor Manufacturer/Model

1. Hach LDO Probe Model 2
2. Endress+Hauser Oxymax COS61D
3. Prior approved equal.

PART 3 - EXECUTION

3.01 LABELING

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number (if applicable) and item description.
- B. Labels shall be engraved laminated plastic with 1/4" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

3.02 CALIBRATION, ADJUSTING AND TESTING

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

3.03 PROJECT MANAGEMENT

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.
- B. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

3.04 FIELD QUALITY CONTROL - INSTALL, START-UP AND WITNESS TESTING

- A. Contractor shall furnish and install raceway and wiring systems for the instrumentation and control system in accordance with manufacturer's requirements and in accordance with Sections 26 05 34. All instrumentation and control system raceways shall be galvanized rigid steel conduit unless specifically indicated otherwise.
- B. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- C. Coordinate installation, start-up and testing scheduling with Owner and Engineer.
- D. Instruct Owner's personnel at the Site on the operation and maintenance of equipment furnished in this Section.
- E. Furnish Owner and Engineer with a written report prepared by Supplier certifying that equipment:
 - 1. Has been properly installed.
 - 2. Is in accurate alignment and calibration and is free from undue stress imposed by interconnecting cable/conduit, etc.
 - 3. Has been operated and witness demonstrated to the Owner under expected conditions and that it operates satisfactorily.

3.05 ON-SITE SERVICES

- A. In addition to other services specified, provide a competent instrumentation engineer or technician to perform the following services:
 - 1. Training – one (1), eight (8) hour day on-Site to train Owner's personnel on:

- a. Operation and maintenance of all equipment furnished under this Section.
- B. All on-Site service shall be at times approved by the Owner.

END OF SECTION 40 75 00

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SECTION 40 76 00
PROCESS GAS ANALYTICAL MEASUREMENT

PART 1 - GENERAL

1.01 REFERENCES

A. Reference Standards:

1. National Fire Protection Association (NFPA) 70 - National Electrical Code (NEC)
2. National Electrical Manufacturers Association (NEMA)
 - a. NEMA ICS-2 - Industrial Control Devices, Controllers and Assemblies
 - b. NEMA 250 - Enclosures for Electrical Equipment
3. Underwriters Laboratories (UL) - 508 Industrial Control Equipment

1.02 SCOPE

- A. It is the intent of the Contract Documents that all equipment specified in this Section of the specification be supplied by the same single-source supplier ("Systems Integrator") specified in Section 40 63 13 unless noted otherwise herein or on engineer's drawings. The supplier shall assume full responsibility along with the Contractor for furnishing, installing and start-up procedures so as to make the system operate per the intent of the Contract Documents.
- B. The Work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training to provide a completely operational process instrumentation and control system.
- C. It shall be the responsibility of the Contractor to furnish a complete and fully operating system. The Contractor shall be responsible for all details that may be necessary to properly install, adjust and place in operation the complete installation. The Contractor shall assume full responsibility for additional costs that may result from unauthorized deviations from the Contract Documents.
- D. It shall be the responsibility of the Contractor and supplier to examine all new equipment that is transmitting a signal to, or receiving a signal from, equipment specified in this Section. The Contractor shall be responsible for providing signal converters, buffer amplifiers, and isolation devices to make signal levels, reference to ground, etc. compatible between devices specified in this Section and existing equipment.

1.03 SUBMITTALS

- A. All submittal requirements stated herein shall be in addition to those outlines in Division 01 of the contract documents.
- B. Technical data in conformance with Section 01 33 00 and including:
 - 1. All equipment and components indicated on the Drawings and specified in Part 2 of this Section
 - 2. Junction Box Enclosures
- C. Shop Drawings in conformance with Section 01 33 00 and including:
 - 1. Control panel and junction box drawings including system schematic drawings, terminal numbering, component schematic drawings, dimension drawings, layout drawing and nameplate schedule. Where panels, junction boxes and new Owner-furnished equipment is being utilized, the submittal shall include complete schematics showing all proposed equipment, terminals, terminal numbering, wiring, elevations, and details. It shall be the supplier's responsibility to visit the Site and inspect existing and Owner-furnished equipment to prepare complete system drawings for the Project.
 - 2. Overall system diagram showing all components, converters, cables, and connectors.
- D. Manufacturer's Instructions
 - 1. Furnish under provisions of Section 01 78 23.
- E. Manufacturer's Field Service Reports
 - 1. Furnish under provisions of Section 01 78 23. Reports should cover a minimum of start up, demonstration, and operational instructions.
- F. Operation and Maintenance data in conformance with Section 01 78 23 and including:
 - 1. Panel equipment, junction boxes, field devices and instruments, including "as-built" system schematics. All items requested under Item 1.04-B.1 above, should be included in their "as-built" form.
- G. Spare Equipment Lists - Provide a list of recommended spare parts and equipment that is considered essential to the operation of the system. Include list of current prices for each item. These lists may be included with the Operation and Maintenance data submittals.
- H. All submittals shall be searchable documents in PDF file type. They shall be electronically delivered through the platform/method all parties mutually agreed upon. The submittal shall be broken up into sections and bookmarked to allow for easier navigation throughout the submittal.

1.04 TESTING AGENCY CERTIFICATION

- A. All new panels and control system junction boxes furnished under this Section shall be constructed in accordance with Underwriter's Laboratories (UL) Standard 508 - "Industrial Control Equipment" or Underwriter's Laboratories (UL) Standard 698 - "Industrial Control Equipment for Use in Hazardous (Classified) Locations".
- B. Each panel shall be shop-inspected by UL or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standard UL 508A or UL 698A.

1.05 CIRCUIT IDENTIFICATION

- A. Each power, control, and signal conductor shall be identified by plastic tags permanently attached to the cable. The tags shall be attached to each cable at each termination and wherever the cable is accessible in junction or pull boxes. Tags shall be marked with printing showing:
 - 1. The circuit number from the cable and conduit schedules.
 - 2. The terminal number as assigned by the equipment manufacturer.
- B. The cable marking system shall use transparent tape with a white area where the numbering shall be typed using a typewriter or computer, as manufactured by:
 - 1. Raychem
 - 2. Thomas & Betts
 - 3. Brady
- C. Contractor supplied "as-built" schematics and wiring diagrams should reflect this described wire identification.

1.06 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a public water system shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

PART 2 - PRODUCTS

2.01 COMBUSTIBLE AND H2S GAS DETECTION

- A. Transmitter General Specifications
 - 1. Voltage: 10.5 - 32VDC
 - 2. Signal Output: Two (2) 4-20mA

3. Relay Outputs: Four (4) Programmable Form C Relays
4. Operating Temperature: -67°F to 185°F
5. Enclosure Rating: 4X / IP67
6. Enclosure Material: Aluminum
7. Display Type: Full Graphic OLED

B. Combustible Gas Sensor General Specifications

1. Sensor Type: IR
2. Range: 0 - 100% LEL
3. Accuracy: +/-2% < 50% LEL or +/-5% > 50%
4. Response: T50 < 4.3 sec, T60 < 7 sec, T90 < 11 sec
5. Temperature Range: -40°F to 167°F
6. Relative Humidity: 0-99% RH Non Condensing
7. Enclosure Material: Aluminum
8. Provide cable to transmitter as needed. Refer to electrical drawings for lengths.

C. Additional Requirements per Sensor

1. Provide additional filter protection from contamination by dirt / moisture
2. Stainless Steel termination box
3. Qty. 1 - Set of Calibration Kits

D. Alarms

1. Audio Notification:
 - a. Style: Vibrating Horn
 - b. Construction: Heavy duty die-cast housing, NEMA Type 4X weatherproof
 - c. Output: Adjustable from 78 to 103 dB
 - d. Input Voltage: 120VAC
 - e. Manufacturer/Model:
 - 1) Edwards Signaling Model 876
 - 2) Prior Approved Equal
2. Visual Indicator Specifications:
 - a. Style: Flashing LED Strobe
 - b. Power: 120VAC
 - c. Flash Rate: 65 fpm
 - d. Color: Red
 - e. Lens: High Impact glass dome
 - f. Listings: UL Class I Div 2
 - g. Enclosure: Weatherproof NEMA 3R and 4X
 - h. Accessories (Per Application):
 - 1) Dome guard
 - 2) 90 degree wall mount bracket

- i. Manufacturer/Model:
 - 1) Edwards Signaling 105XBRMR120A
 - 2) Prior Approved Equal

E. Schedule

- 1. Gas Sensor/Transmitter shall be furnished and installed for the following application(s):
 - a. Within PTB Electrical Room
 - b. _____
 - c. _____
 - d. _____
 - e. _____

F. Spares

- 1. Provide One (1) complete spare Sensor/Transmitter per type that is being supplied.
- 2. Provide One (1) complete spare Audio/Visual Indicator per type that is being supplied.

G. Manufacturer/Model

- 1. Transmitter
 - a. Emerson Millennium II Series M22
 - b. MSA Ultima X5000
 - c. Prior Approved Equal
- 2. Combustible Gas Sensor
 - a. Emerson Millennium II Series SC311
 - b. MSA Ultima X5000
 - c. Prior Approved Equal
- 3. Alarms
 - a. Audio Indicator
 - 1) Edwards Signaling 877 Series
 - 2) Prior Approved Equal
 - b. Visual Indicator
 - 1) Edwards Signaling 105XBRM Series
 - 2) Prior Approved Equal

PART 3 - EXECUTION

3.01 LABELING

- A. Label all field mounted control devices, instrumentation, switches, etc., with tag number (if applicable) and item description.

- B. Labels shall be engraved laminated plastic with 1/4" high lettering. Labels shall be attached with stainless steel screws to the device or nearby wall.

3.02 CALIBRATION, ADJUSTING AND TESTING

- A. Devices requiring field calibration shall be calibrated in the presence of the Engineer's representative and documented.

3.03 PROJECT MANAGEMENT

- A. Supplier shall provide engineering and administrative services necessary to fulfill the requirements of this Specification.
- B. Supplier shall provide the services of an experienced project manager as the overall coordinator during the course of the project.

3.04 FIELD QUALITY CONTROL - INSTALL, START-UP AND WITNESS TESTING

- A. Contractor shall furnish and install raceway and wiring systems for the instrumentation and control system in accordance with manufacturer's requirements and in accordance with Section 26 05 34. All instrumentation and control system raceways shall be galvanized rigid steel conduit unless specifically indicated otherwise.
- B. Supplier shall provide a skilled programmer/instrumentation engineer or technician who shall complete troubleshooting and start-up to place the entire system into satisfactory operation. The engineer or technician shall make the necessary inspection of the completed installation, make the necessary final field adjustments, and make program revisions as required for start-up.
- C. Coordinate installation, start-up and testing scheduling with Owner and Engineer.
- D. Instruct Owner's personnel at the Site on the operation and maintenance of equipment furnished in this Section.
- E. Furnish Owner and Engineer with a written report prepared by Supplier certifying that equipment:
 - 1. Has been properly installed.
 - 2. Is in accurate alignment and calibration and is free from undue stress imposed by interconnecting cable/conduit, etc.
 - 3. Has been operated and witness demonstrated to the Owner under expected conditions and that it operates satisfactorily.

3.05 ON-SITE SERVICES

- A. In addition to other services specified, provide a competent instrumentation engineer or technician to perform the following services:

1. Training – two (2), eight (8) hour days on-Site to train Owner's personnel on:
 - a. Operation and maintenance of all equipment furnished under this Section.
- B. All on-Site service shall be at times approved by the Owner.

END OF SECTION 40 76 00

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DIVISION 43
PROCESS GAS AND
LIQUID HANDLING,
PURIFICATION &
STORAGE EQUIPMENT

SECTION 43 11 33
ROTARY LOBE BLOWERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnishing and installation of the following equipment in accordance with the provisions of the Contract Documents:
 - 1. One (1) Rotary Lobe Blower Assemblies, complete and operational with all control equipment and accessories.
 - 2. Blower Sound Enclosures.
 - 3. Blower Pipe, Fittings, Gauges, Valves, and Accessories.
- B. All equipment specified in this section shall be coordinated with SBR manufacturer and controllable by SBR equipment manufacturer.
- C. Related Sections include:
 - 1. Section 01 33 00 - Submittal Procedures
 - 2. Section 01 45 00 - Quality Control
 - 3. Section 01 61 00 - Common Product Requirements
 - 4. Section 01 75 00 - Starting and Adjusting
 - 5. Section 01 77 00 - Closeout Procedures
 - 6. Section 01 78 23 - Operation and Maintenance Data
 - 7. Section 01 91 00 - Commissioning
 - 8. Section 09 90 02 - High Performance Painting and Coating
 - 9. Section 46 50 16 - Sequencing Batch Reactor System

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASTM)
- B. National Electrical Code (NEC)
- C. National Electrical Manufacturers Association (NEMA)
- D. American Gear Manufacturers Association (AGMA)
- E. Anti-Friction Bearing Manufacturers Association (AFBMA)
- F. International Organization of Standardization (ISO)
- G. NFPA 820: Comply with most current edition of National Fire Protection Association Standard for Fire Protection in Wastewater Treatment and Collection Facilities for electrical equipment installed within borders indicated on the Project Drawings.

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00, detailed specifications, drawings, blower curves, certified test results, blower octave band analysis, PRV sizing data, and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.
- B. Provide performance curves for each blower. Blower Discharge Curves shall be approved by Engineer before shipping blowers. Blowers that do not meet performance curve requirements will not be acceptable. Blower performance shall be calculated according to manufacturer's published standards upon the condition existing at the blower flange, considering any temperature rise and pressure drop within the enclosure and within the silencers.
- C. Assemblies that do not meet noise level requirements will not be acceptable.
- D. Furnish Manufacturer's field service reports under provisions of Section 01 33 00, reports covering start up, adjusting, commissioning, demonstration, and training.
- E. Submit operation and maintenance manuals and Manufacturer's instructions in accordance with Section 01 33 00 and Section 01 78 23.
- F. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.04 SYSTEM DESCRIPTION

- A. Provide rotary lobe positive displacement blowers of three lobe design with sound enclosures, and flanged inlet and discharge connections.
- B. Seller shall provide a total of one (1) blower. Blower shall meet aeration requirements for the continuous flow SBR aeration system.
- C. There shall only be four (4) easily accessible anchor points to secure blower to concrete floor/equipment pad. Blower shall be provided with vibration isolating mounts on the bottom to reduce sound and vibrations transferring to concrete floor slab.
- D. Blower shall have flanged inlet and discharge connections.
- E. Blower assembly shall be provided with a blower, V-belt drive and motor, belt sheaves, belts, belt guards, assembly base, adjustable motor base, oversized inlet filter, differential pressure gauge filter indicator, pressure relief valve, check

valve, pressure gauge, temperature switch, inlet and outlet silencing equipment and sound enclosure.

- F. Blower and motor shall be operated with variable frequency drives to vary the air flow to the SBR system based upon the volume and energy required for maintaining dissolved oxygen.

1.05 QUALITY ASSURANCE

- A. The equipment supplier must have at least five continuous years' experience in the design, application and manufacture of rotary lobe blower assemblies. All material and equipment shall be new and of the highest quality.
- B. Blowers, motors, bases, filters, gauges, valves, silencers, sound enclosures, and all other specified accessories and appurtenances shall be furnished by a single manufacturer or supplier to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- C. All painting shall be per Supplier's standards, including purchased components such as gear reducers, pumps, motors, valves, and appurtenances.
- D. To assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these specifications that all rotary lobe positive displacement blower assemblies and accessories called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the CMAR, assume the responsibility for proper installation and functioning of the equipment.
- E. Drawing layouts, item weights and specification language for the blower assemblies are based on Roots. Modifications, including but not limited to, process, mechanical, electrical and structural modifications, required for other approved manufacturer's equipment may be necessary and shall be included in the CMAR's bid price.

1.06 DELIVERY STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the OWNER until required for installation. Materials shall be transported, delivered, stored and handled in accordance with manufacturer's instructions and the requirements of Section 01 61 00.
- B. Comply with the pertinent provisions of the delivery schedule. Coordinate delivery with CMAR.
- C. Equipment and materials to be shipped F.O.B. shipping points, with freight prepaid to the jobsite. Fabricated parts when delivered to the site shall be stored

off the ground and protected from weather and damage. Control and electrical devices shall be stored indoors.

- D. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.
- E. See additional requirements in Section 01 65 00.

1.07 WARRANTY REQUIREMENTS

- A. The equipment manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of five (5) years under normal use, operation and service. Warranty package components for a period of one (1) year. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty. Multiple warranties for individual components shall not be acceptable.
- B. Warranty period shall begin after completion of performance and operation testing or after written acceptance of the installation by ENGINEER, whichever occurs earlier.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Rotary Lobe Blowers
 - 1. Roots
 - 2. Aerzen
 - 3. Kaeser
 - 4. Or Approved Equal
- B. The equipment specified herein is intended to be standard equipment for use in low pressure air systems and be supplied by a single manufacturer or authorized sales representative to assure uniform quality, ease of maintenance, and minimal parts storage.
- C. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section.

2.02 PERFORMANCE REQUIREMENTS

- A. Aeration Basins Rotary Lobe Positive Displacement Blowers

Number of Blowers	1
Blower IDs	SBR1-PB4
Design Flow	800 SCFM
Design Discharge Pressure	8.2 PSIG
Design Ambient Temperature	90 degrees Fahrenheit
Design Maximum Blower Inlet Temperature	104 degrees Fahrenheit
Design Minimum Blower Inlet Temperature	-25 degrees Fahrenheit
Design Relative Humidity	50%
Site Elevation	4930 FT MSL
Ambient Atmospheric Pressure	12.0 PSIA
Inlet Pressure Loss (Max)	0.2 PSI
Inlet Pressure (at blower inlet connection)	11.8 PSI
Motor Horsepower	50 HP
Speed Control	Variable Frequency Drive
Free Field Noise Guarantee	98 dB(A) or less @ 1 m (@ design pt)
Minimum Bearing L-10 Life	167,000 HRS

- B. Blowers operating at higher RPMs may be acceptable subject to approval by Engineer. Blowers operating at higher RPMs will be acceptable upon approval of Engineer based on bearing life calculations.
- C. The blower assembly with sound proof enclosure shall not exceed a noise level of 80 dBA, measured at 1 meter from enclosure, at four equally spaced locations, 5 feet above the floor with no reflective surfaces within 2 meters of enclosure, with one unit running.
- D. The blower package shall not exceed an overall vibration level of 1.0 inch/second. Measurements shall be taken at the blower and motor front and rear bearing locations in the vertical, horizontal and axial planes with the blower package operating at design speed and discharge pressure.
- E. Blower piping (intake and discharge), intake filters, and silencers will be sized such that airflow velocities do not exceed those identified in the table below.

Typical air velocities in aeration header pipes (Metcalf & Eddy Table 5-28)		
Pipe diameter	Velocity Min	Velocity Max
[in]	[ft/min]	[ft/min]
1-3	1200	1800
4-10	1800	3000
12-24	2700	4000
30-60	3800	6500

- F. Inlet Configuration: piped.
- G. All components and instrumentation are to be mounted and pre-piped; no field installation shall be required by the CMAR. The manufacturer shall be responsible for all aspects of the engineering, from the blower package's air inlet to its discharge connection

2.03 BLOWERS

- A. The blower casing shall be one-piece, with separate headplates, and shall be made of ASTM A48 Class 30B close-grained cast iron. Each headplate shall incorporate a vent to atmosphere. In a pressure application, this vent prevents pressurization of the oil chambers.
- B. Rotating parts of each blower shall be statically and dynamically balanced before final assembly. Removal of material from the face of the rotors for balancing purposes is not acceptable.
- C. 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.
- D. Each impeller and shaft assembly shall be supported by oversized anti-friction bearings engineered for long service life and fixed to control the axial location of the impeller shaft in the unit. A cylindrical roller bearing shall be provided at the drive shaft designed to handle the stresses of drive, while single-row ball or cylindrical roller bearings shall be used at all other locations. On 6" and 7" sized blowers, a wavey washer shall be installed on the gear end of both shafts to counter axial thrust.
- E. The impellers shall be timed by a pair of SAE 8620 carburized and hardened steel spur gears. The gears shall be hardened to 58-Rockwell minimum hardness and mounted on the shafts with tapered fit, and secured by a locknut.
- F. All fasteners shall be SAE J429-Grade 5, ASTM A449-Type 1, material minimum.
- G. Each bearing housing shall include a positive lip-type Viton oil seal or PTFE hydrodynamic lip seal designed to prevent lubricants from entering the air stream. A viton or PTFE lip seal shall be installed on the drive end of the drive shaft. Splash oil lube on gear and grease lube on drive end.

2.04 MOTORS

- A. Motors shall be sized for the appropriate horsepower, RPM, and other appropriate characteristics as required for the application. The brake horsepower with the relief valve fully open shall not exceed the motor nameplate horsepower rating with service factor.

- B. Provide 1750 RPM, 460 Volt, 3 phase, 60 Hz designed for inverter duty, with winding thermal switches, conforming to Division 26. CMAR responsible for connection of PTC thermistors to VFD. See Section 26 05 10 - Motors for further information.
- C. The motors shall be rated NEMA premium efficient by manufacturer. Motors shall meet additional requirements of Section 26 05 10.
- D. Motors shall be constructed with a TEFC enclosure suitable for operation at 1.15 times the nameplate horsepower rating when operating at the temperature within the enclosure.

2.05 BELT DRIVES AND GUARDS

- A. A v-belt drive shall be provided. The belt drives shall be selected with a 1.5 service factor at the ambient temperature with the enclosure at full load. For v-belt drives 75 hp and larger, banded belts shall be required.
- B. The measurement of belt tension must be easily performed without the removal of the belt guard or loosening the motor mounting bolts.
- C. The belt tension device must be designed to allow maintenance personnel to replace the belts without exerting a lifting capacity of over 40 lbs without the use of lifting, jacking, or pulling tools.
- D. The belt guard shall meet OSHA specifications.
- E. The belt guard cover shall be easily removed without removing the sound enclosure.

2.06 ASSEMBLY BASE

- A. The assembly base shall consist of welded steel suitable for mounting of the blower, motor, belt guard, motor base, discharge silencer, inlet filter, differential pressure gauge filter indicator, temperature switch and sound enclosure.
- B. All welds and metal edges shall be ground smooth.
- C. The assembly base shall be bolted to the foundation through no less than 4 bolt holes provided by the base manufacturer. Foundation bolts will be no less than 4 inches from the edge of the blower foundation slab. Isolation and damping devices shall be installed between base, concrete pad, and floor slab to minimize vibration.
- D. Provide isolation material between blower pad and building floor slab as well as isolation system between blower assembly base and blower pad to minimize vibration. The blower manufacturer must ensure proper selection for the specific blower system provided.

2.07 ADJUSTABLE MOTOR BASE

- A. The motor shall be factory mounted on a motor base that is separate from the assembly base and which provides adequate adjustment for easy removal and installation.
- B. The motor base shall include at least two adjustable bolts to assure accurate alignment of sheaves.
- C. Adjustment of the motor base shall be capable of being easily performed without disassembly of the sound enclosure.

2.08 ENCLOSURE

- A. An 80 dBA or less free field guaranteed sound enclosure shall be provided with each blower. The sound enclosure shall be suitable for indoors operation and shall enclose the entire machinery package. Manufacturer shall size enclosure to be compatible with blower.
- B. The exterior of the enclosure shall be fabricated of 12 gauge steel. The exterior must be designed to withstand potential impacts without substantial damage.
- C. The enclosure is to be of a bolted or screwed panel construction.
- D. Access Cover(s)
 - 1. Access covers shall allow removal of the blower and motor vertically upward or the need to remove silencers.
 - 2. Checking, changing, and adding lubricant shall be capable of being performed with a maximum requirement of opening four locking mechanisms.
 - 3. Bullnose oil sight level shall be visible when the maintenance panel is removed.
 - 4. An oil drain and shutoff valve shall be provided.
 - 5. The access cover shall have a watertight seal.
 - 6. Access cover shall be designed to allow easy access for the following:
 - a. Changing blower oil/grease.
 - b. Observing blower oil level.
 - c. Greasing motor bearings.
 - d. Checking drive alignment.
 - e. Wiring to the electric motor.
 - f. Wiring to the package terminal strip.
- E. Cooling and Insulation
 - 1. The enclosure shall be fabricated so that ambient process air flows through an internal sound plenum, built integral to the enclosure, directing air across the motor.

2. A separate cooling unit is required. CMAR shall provide separate wiring and controls for the cooling fan. Fan shall be 1/4 HP, 115V, 1PH, 3.8FLA, 60 Hz.
 3. The discharge silencer shall be thermally insulated with R6 (2" thick) insulation to prevent unnecessary buildup of heat within the enclosure.
 4. Panel insulation shall comply with UL94-HF 1 for flammability.
- F. The enclosure shall be an integral part of the blower assembly. The blower assembly shall be shipped with the enclosure mounted so that factory quality, as tested, shall be consistent with all units.

2.09 INLET FILTERS/SILENCERS

- A. Each package shall be supplied with one primary inlet filter/silencer and one secondary inlet filter and silencer.
- B. The inlet filter shall be 99.5 efficient at removing 2 micron particles and larger. The pressure drop of inlet filter shall not exceed 3 inches water gauge pressure at the rated inlet air flow rate.
- C. Secondary air inlet filter shall be provided inside the blower package units. The inlet filter shall be mounted by the manufacturer.
- D. The primary inlet air filter/silencer shall be located outside the building on the inlet. Primary inlet air filter/silencer shall have a rated flow capacity of a minimum of 300% greater than the maximum inlet volume determined by the performance criteria. Velocities through intake filters/silencers shall also not exceed those listed under Performance requirements, above. All manufacturer's piping shall be sized to match the connection(s) of the filter/silencer.
- E. Primary inlet filter/silencer shall be designed to withstand and operate year-round at exterior exposure to the local climate at the Point of Destination.
- F. The silencer portion shall be located upstream of the inlet filter.
- G. The filter element shall be designed to trap dirt on the inside so that upon changing, dirt does not fall into the machinery.
- H. Filter and silencer performance losses (clean element) shall be included in the entire package performance calculation.
- I. The primary filter element must be changeable without the use of tools and without the need to remove any portion of the sound enclosure.
- J. Approved primary inlet filter manufacturers
 1. Endustra Trivent Series P09
 2. Approved Equivalent

2.10 SILENCERS

- A. The discharge silencer shall be wear-free absorptive design.
- B. The discharge silencer shall be suitable for attaining the specified noise level.

2.11 ENCLOSURE TEMPERATURE SWITCH

- A. The blower package shall include an installed temperature switch that measures the temperature inside of the blower package's enclosure. SPDT, voltage rating up to 250v, 2.5A.
- B. The switch shall be factory set to 140°F.
- C. Switch shall be factory wired to shut down the blower package when actuated.

2.12 PRESSURE RELIEF VALVE

- A. The pressure relief valve shall be Kunkle type spring loaded factory set valve, and relief capacity of not less than design condition capacity SCFM at maximum allowable blower pressure and speed.
- B. The valve shall be located between the discharge silencer and the check valve, factory installed, vented outside the enclosure.

2.13 CHECK VALVE

- A. A check valve to prevent back flow through the blower shall be factory installed and not shipped loose for field installation in the discharge piping.
- B. The check valve flapper shall be swing type made from a steel disc embedded in a high temperature silicone elastomer. The valve shall be designed so that, in the event of failure, the valve element is retained in the valve housing. Split disc or center hinged designs shall not be used.
- C. The check valve capacity shall exceed the blower package's maximum discharge pressure and temperature.

2.14 FLEXIBLE CONNECTOR

- A. An elastomeric compensator/flex connector shall be provided to isolate the connection of the blower package to the self-supporting system piping. Restraining rods shall not be used. Flex connectors located between the bare blower and silencers shall not be allowed.
- B. The flexible connector capacity shall exceed the blower package's maximum discharge pressure and temperature.
- C. Discharge connection

1. 4" and smaller connection, a web reinforced silicone rubber sleeve with corrosion resistant clamps shall be provided.
2. 6" and larger connection, a ANSI/DIN flanged arch-type EPDM web reinforced connector shall be provided.

D. Piped Inlet connection

1. 6" or smaller connection, a web reinforced silicone rubber sleeve with corrosion resistant clamps shall be provided.
2. 8" and 10" piped inlet connection, an arch-type EPDM web reinforced sleeve with corrosion resistant clamps shall be provided.
3. 10" ANSI/DIN flanged inlet connection, an ANSI/DIN flanged arch-type EPDM web reinforced connector shall be provided.

2.15 INSTRUMENTATION GAUGES

- A. The following gauges shall be pre-piped and panel mounted on the front of the sound enclosure.
1. Discharge pressure gauge
 - a. The discharge pressure gauge shall measure the pressure at the discharge of the blower.
 - b. The discharge pressure gauge shall be dual unit (English – PSI / Metric – Bar) with a range of 0 – 23 psi (0 – 1.6 bar). Minimum dial diameter shall be 2 ½", made with a black plastic case and be glycerin filled measuring system converted by a Bourdon tube into a rotary movement of the pointer.
 2. Filter differential pressure gauge
 - a. The filter differential pressure gauge shall measure the pressure difference from ambient to the back side of the filter that is integral to the blower package's inlet silencer. When the filter starts to become dirty, the resistance shall be shown on a resettable red dial indicating when the filter shall be changed.
 - b. Minimal dial diameter shall be 2 ½".
 3. Discharge temperature gauge
 - a. The discharge temperature gauge shall measure the temperature at the discharge of the blower package.
 - b. The discharge temperature gauge shall be dual unit (English - °F / Metric - °C) with a range from 32 – 392°F (0 – 200°C) and include an adjustable set point dial. Minimal dial diameter shall be 2 ½", made with a black plastic case.

2.16 INSTRUMENT SWITCHES

- A. The blower package shall include an instrumentation junction box where all the provided instrumentation is wired to a terminal strip making for a central electrical connection point (except for the main blower drive motor). All switches shall be individually wired to the junction box so that each individual alarm can be

monitored separately by the SCADA system. CMAR to provide connection from junction box to control system.

- B. All contacts shall be normally closed and open on an alarm condition. Switches shall be rated for 5A at 120VAC minimum.
- C. The following switches shall be prewired to the integral instrumentation junction box.
 - 1. Discharge temperature switch
 - a. The rotary movement of the temperature gauge pointer spindle shall operate a SPDT microswitch through a lever system. Voltage rating up 220v, 5amps.
 - b. High temperature set point shall be as recommended by blower manufacturer.
 - c. Switch shall be wired to shut down the blower package when actuated.
 - 2. Discharge pressure switch
 - a. The blower package shall include an installed discharge pressure switch that shall measure discharge pressure of the blower.
 - b. The discharge pressure switch shall be field adjustable.
 - c. The discharge pressure switch shall be a SPDT switch, Voltage rating up to 250v, 5A.
 - d. Switch shall be wired to shut down the blower package when actuated.
 - 3. Enclosure safety switch
 - a. The blower package shall include an installed enclosure safety switch that shall thermostatically measure the temperature inside of the blower package's enclosure.
 - b. The enclosure safety switch shall be field adjustable and set at 140 deg F (60 deg C).
 - c. The enclosure safety switch shall be a SPDT switch, Voltage rating up to 250v, 5 A.
 - d. The switch shall be wired to shut down the blower package when actuated. It shall not be wired to turn on the enclosure vent fan.

2.17 BLOWER PACKAGE CONTROLS AND INSTRUMENTATION

- A. Blower shall be provided at a minimum with differential pressure switch, discharge temperature switch, and motor over temperature thermistors, pre-wired to manufacturer supplied controller mounted on or within the blower enclosure package. All contacts shall be normally closed and open on an alarm condition. Switches shall be rated for 5A at 120VAC minimum. All switches shall be individually wired to the junction box so that each individual alarm can be monitored separately by the SCADA system.
- B. The output contacts shall be wired to the blower VFD and plant SCADA system by Division 26 to monitor and protect the blower by disabling the Division 26 provided variable frequency drive in the event of abnormal operating conditions.

- C. Blower drive motor shall have normally closed thermostats embedded in the windings with leads wired to the terminal box. See Division 26 for additional requirements.
- D. Exterior inlet filter differential pressure switch shall be plumbed to measure the pressure difference between the inlet of the filter and the outlet of the filter. Switch shall alarm if the inlet filter differential exceeds 50 mb. The switch shall be wired to the terminal box.
- E. The enclosure shall have SPST contacts that close on high temperature, rated 5 amps at 120 VAC minimum, wired to the terminal box.
- F. Provide delay relay for cooling fan to allow fan to run for set time after blower motor power is de-energized, wired to the terminal box.

2.18 ACCESSORIES

- A. Fittings and valves necessary outside manufacturer's enclosure for a complete and operational system shall be provided by CMAR.
- B. Provide flanged filled expansion joints, Mercer Rubber Company 450, or equal, suitable for 300°F service and connection to the discharge silencer.
- C. Provide butterfly valves with cast iron body; cast iron ASTM A126B with polyamide coating.

2.19 SURFACE PREPARATION AND PAINTING

- A. All equipment shall be factory coated in accordance with manufacturers standard procedures.

2.20 ANCHOR BOLTS

- A. CMAR shall provide anchor bolts of ample size and strength required to securely anchor each item of equipment in accordance with equipment manufacturer's requirements. Bolts, washers and hex nuts shall be AISI Type 304 stainless steel unless noted otherwise. Anchor bolts shall be adhesive-type stainless steel.
- B. Anchor bolts shall be set by the CMAR using templates provided by the equipment manufacturer. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.21 SPARE PARTS

- A. Furnish lubricating materials to allow for one year of operation. Lubricating materials shall be as recommended by the manufacturer.

- B. Furnish the following manufacturer's recommended routine maintenance spare parts for each blower package provided:
 - 1. Two (2) filter elements for integral inlet silencer
 - 2. Lubrication for first year of operation
 - 3. One (1) belt set
 - 4. Two (2) fuses of each type supplied
 - 5. Two (2) filter mats for blower control cabinet (Integrated OFC-VFD blower package)
 - 6. One (1) tube of motor grease (50HP or larger)

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall install the blower packages per the Manufacturer's directions and the drawings. The Contractor will provide all supports and anchoring required to install the blower units. The plumbing/interconnecting piping, electrical connections, and appurtenances shall be provided by the Contractor as detailed on the drawings and specifications. The Manufacturer will provide adequate protection of the equipment for shipment to the project site. Installation instructions will be provided that specifically outline installation of the filter. Lifting instructions will be provided to assist the Contractor.
- B. See Section 46 05 01 for additional requirements.

3.02 INSTALLATION

- A. The Manufacturer shall furnish the services of a factory-trained representative based in the United States and employed by the manufacturer, for a maximum of four (4) working days, not including travel days, and two (2) separate trips. These two trips shall consist of one (1) trip to monitor the installation, functional testing, and start-up of the installation and one (1) trip for performance and operational testing and instruction of plant operating personnel. The Contractor will provide to the Manufacturer a minimum prior notice of three (3) weeks to schedule these services.
- B. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the contractor, the additional service days will be at the Contractor's expense.
- C. Installation inspection, start-up, and operator instruction shall be coordinated with the Installation Contractor. All equipment must be in operating condition and ready for Supplier's Field Technician when called to the project location.
- D. Install all equipment per the manufacturer's recommendations.

- E. Systems to be installed complete with all necessary connections, valves, pipes, and fittings.
- F. CMAR responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.
- G. CMAR shall complete all electrical power and control connections as specified in Division 26.

3.03 STARTING AND ADJUSTING

- A. Supplier shall provide starting and adjusting services, including but not limited to, required adjustments, test, operation checks and other start up activities.
- B. Inspect equipment for cleanliness prior to start up.
- C. Confirm equipment is properly anchored and supported.
- D. Manufacturer's Service
 - 1. Each packaged blower shall be run for a minimum of fifteen minutes by Manufacturer prior to shipping.
 - 2. Provide services of an Experienced, Competent and Authorized Representative of Manufacturer for a minimum of eight (8) hours. Additional Manufacturer services for starting and adjusting shall be the responsibility of the CMAR.
 - 3. Reference Sections 01 45 00, 01 75 00, 01 91 00, and 46 05 01 for additional requirements.

3.04 COMMISSIONING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. CMAR shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.
- B. Performance and Operational Testing period shall demonstrate that the aeration system as a whole will have the capacity to maintain dissolved oxygen concentration at, or above, the specified criteria.

3.05 PERFORMANCE AND OPERATION TESTING

- A. Supplier shall provide assistance to Installation Contractor during Performance and Operational Testing.
- B. Final acceptance of equipment will not be provided until completion of Performance and Operational Testing (POT).

- C. Performance and Operation Testing period shall demonstrate that the blower units meets the performance requirements of this specification for the duration of the POT.
 - 1. POT test number one shall consist of 3 hours operation of each package. Successful demonstration shall be defined as all package components are working properly and vibration levels and noise levels are within acceptable limits at maximum blower speed. Where possible, flow and pressure readings shall be recorded at 30 minute intervals.
 - 2. POT test number two shall demonstrate a fully functional system in automatic and manual modes for a period of fifteen (15) days.
- D. Provide commissioning plan and meet additional requirements of Section 01 91 00. CMAR shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.

3.06 CLASSROOM AND DEMONSTRATION TRAINING

- A. Supplier shall provide four (4) hours of operator training by a qualified representative of the manufacturer for Owner's personnel after system is operational. Training will occur on a schedule convenient to the Owner. Training will not take place while manufacturer's representative is at the job site during start up or functional testing, but may take place during POT. Ratio of classroom-time-to-demonstration-time shall be determined on training day by Buyer upon an as-needed basis to provide Buyer with satisfactory training.
- B. CMAR shall record training via digital video camera so Owner can use again in the future.
- C. CMAR shall meet additional requirements as required in Section 01 79 00.

END OF SECTION 43 11 33

SECTION 43 21 14
RECESSED IMPELLER VORTEX TYPE SLURRY PUMPS

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes all labor, materials, equipment, and incidentals required to provide:
 - 1. Grit Pump in the Pretreatment Building.
 - 2. The Manufacturer shall also provide installation inspection, field testing, startup and training, after the equipment has been installed by the Contractor. The unit shall be furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, and as required for an installation incorporating the highest standards for the type of service specified, including field technician representation during start up of the unit, and instruction of the Owner's personnel in the care, operation and maintenance of all equipment.
 - 3. The Supplier must clearly identify in detail all exceptions to the Services and Scope of Supply described in this Specification and include such list with their grit removal system proposal package
- B. Related Sections include, but are not limited to:
 - 1. Division 1 - General Requirements
 - 2. Division 26 - Electrical
 - 3. Division 40 - Process Interconnections
 - 4. Section 46 05 01 - Wastewater Equipment General Provisions
 - 5. Section 46 23 00 - Grit Removal System

1.02 REFERENCES

- A. Reference Standards:
 - 1. American Bearing Manufacturers' Association (ABMA).
 - 2. American Gear Manufacturers Association (AGMA).
 - 3. American Iron and Steel Institute (AISI)
 - 4. American National Standards Institute (ANSI).
 - 5. American Petroleum Institute (API).
 - 6. ASTM – American Society for Testing and Materials (ASTM).
 - 7. American Society of Mechanical Engineers (ASME).
 - 8. American Water Works Association (AWWA).
 - 9. Hydraulic Institute Standards (HIS).
 - 10. National Electrical Code (NEC).

11. National Electrical Manufacturers Association (NEMA).
12. Occupational Safety and Health Act (OSHA).

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00. In general, include detailed data covering specifications, drawings, materials, parts, motors, sizes, capacities, dimensions, weights, lifting points, parts list, spare parts, clearance distances, wiring diagrams, controls, and other accessories forming part of equipment for the complete operational system.
- B. Pumps:
 1. Name of manufacturer.
 2. Type of model.
 3. Design rotative speed.
 4. Type of pump bearings.
 5. Type of lineshaft bearings.
 6. Size of shafting.
 7. Diameter of impeller.
 8. Weight of complete assembly, including motor.
 9. Complete performance curves showing capacity, head, NPSH requirements, efficiency, and bhp requirements.
 10. Type of seals.
 11. Complete drawings showing dimensions, fabrication, installation, and manufacturers requirements.
 12. Materials of component construction.
- C. Furnish manufacturer's certified performance test results for each pump supplied. Results of tests to be reviewed by the Engineer before pumps are shipped from the manufacturer. Pumps that do not meet performance curve requirements shall not be acceptable. Pump performance shall be calculated according to manufacturer's published standards.
- D. Furnish Manufacturer's field service reports under provisions of Section 01 33 00, reports covering start up, adjusting, commissioning, demonstration, and training.
- E. Submit operation and maintenance manuals and Manufacturer's instructions in accordance with Sections 01 33 00 and 01 78 23.
- F. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.04 DESCRIPTION OF WORK

A. Provide:

1. One (1) duty horizontal, severe duty, non-clog vortex type slurry grit pump in the Pretreatment Building as indicated on the Drawings. The system shall include a horizontally recessed impeller vortex type slurry pump capable of pumping grit collected from the bottom of a vortex tray grit removal system. The pump shall include all necessary accessories and work to complete installation of the system.
2. One (1) additional standby pump shall be provided and stored per Owner's instruction. The standby pump shall be identical to the provided duty pump and shall be capable of being installed immediately if the primary duty pump is out of service.

B. The grit pump shall convey the concentrated grit slurry from the underflow of the grit removal unit to the grit washing and classification unit.

C. Pumps shall be rated for continuous duty at the specified operations points, and be provided complete with all accessories, controls and appurtenances as required for a complete operating system.

D. The grit removal system, grit pump and all appurtenances shall be supplied by a single supplier. Multiple manufacturers are acceptable as long as they are compatible and all under a single supplier or authorized sales representative. The integrated grit cyclone and classifier shall be provided by a single manufacturer.

E. The system to be furnished hereunder shall be made by a Manufacturer regularly engaged in such work and who has furnished similar installations and had them in successful and continuous operation for a minimum period of ten years.

F. Data on performance testing, service history and operation of existing installations using the submitted equipment shall be made available to the Engineer, upon request, for use in determining that the grit removal components offered meets the intent of the contract, performance requirements and criteria stated in these specifications.

G. All components of the grit removal system located in the building and dumpster area shall be designed to be explosion proof.

H. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the Grit System in accordance with the installation instructions provided by the Supplier. Once installed, the Grit System shall be complete and operational with all control equipment and accessories as specified herein or as otherwise required for a fully functional and operational system. The Screen Supplier must clearly identify in detail all exceptions to the Services

1.05 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of five (5) years experience producing equipment substantially similar to that required and shall be able to submit documentation of at least five (5) independent installations using the same size or larger equipment as detailed in the below. Each installation must have been in satisfactory operation for at least five (5) years. All material and equipment shall be new.
- B. Pumps (both duty and shelf-spares), complete with motor, baseplate, necessary guards, and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- C. In order to assure uniform quality, ease of maintenance, minimal parts storage, compatibility, integrity of the individual components, and provide the specified warranty for all components, it is the intent of these specifications that all equipment and components called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- D. The Contract Documents represent the minimum acceptable standards for the equipment for this project. Equipment shall conform fully in every respect to the requirements of the respective parts and sections of the Preliminary Drawings and specifications. Manufacturers shall modify, redesign, and furnish with special features or accessories, use materials or provide equipment with finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of this specification.
- E. Drawing layouts, item weights and specification language for the grit pump system are based on Wemco. Modifications, including but not limited to, process, mechanical, electrical and structural modifications, required for toher approved manufacturer's equipment may be necessary and shall be included in the Contractor/Construction Manager At-Risk's bid price.
- F. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including top of motor, shall not exceed the maximum velocity as indicated for vertical, end suction, solids handling pumps in Figure 9.6.4.10 of the governing standard (HIS). At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Installation Contractor until required for installation. Materials shall be transported, delivered, stored and handled in accordance with manufacturer's instructions and the requirements of Section 01 65 00.
- B. Freight paid by equipment Supplier.
- C. Final delivery schedule shall be coordinated with Contractor.

1.07 WARRANTY

- A. The equipment Manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of one (1) years under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty. Multiple warranties for individual components shall not be acceptable.
- B. Warranty period shall begin after completion of performance and operation testing or after written acceptance of the installation by Engineer, whichever occurs earlier.

1.08 FACTORY TESTING

- A. Pumps shall be factory tested. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at rated head, shutoff head, operating head extremes, and at as many other points necessary for accurate performance curve plotting.
- B. Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, bhp brake kW, pump efficiency, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements. All test points shall be clearly shown.

1.09 MAINTENANCE AND SERVICE

- A. Manufacturer's authorized representative shall have his own full time repair service available on 24-hour call.
- B. A factory serviceman and service vehicle equipped with tools to make all necessary repairs, as well as component parts required to maintain satisfactory

operation of the equipment outlined in these specifications, shall be available if needed, without undue delay.

- C. Representatives shall maintain a local stock of parts for each model of pump bid.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Trillium Wemco Torque-Flow, Model CE; Houston Texas
- B. Hayward Gordon, Model XR
- C. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section. Any deviations without sufficient evidence proving equal or superior quality shall be rejected without further review or comment.

2.02 PERFORMANCE AND DESIGN REQUIREMENTS

- A. Pumping units shall be designed for following performance and design requirements:

Location/Purpose	Grit Pumps
Equipment Tag	GP1
Number of Pumps	2 (1 spare)
Speed Control	Sheave Adjustment
Type	Recessed Vortex Slurry
Minimum Sphere Size (in.)	2.5
60 Hz Static Head (ft)	11
60 Hz Total Dynamic Head (ft)	35
60 Hz Maximum Flow (gpm)	300
Minimum Efficiency at Maximum Flow (%)	30
Net Positive Suction Head Available (ft)	30
Maximum Net Positive Suction Required (ft)	20
Minimum Shutoff Head (ft)	38
Maximum Nominal Pump Speed (rpm)	1,080
Maximum Horsepower (HP)	10
Minimum Impeller Size (in)	11"
Maximum Vibration Velocity	HIS
Minimum Pump Inlet Size (in.)	3
Maximum Pump Inlet Size (in.)	4
Minimum Pump Outlet Size (in.)	3
Maximum Pump Outlet Size (in.)	4

1. All specified conditions shall be at rated speed unless otherwise noted.
2. Pumps operating at lower RPMs may be acceptable subject to approval by Engineer. Pumps operating at higher RPMs shall not be acceptable.
3. Pumps shall be non-overloading of the motor, excluding service factor, throughout the entire pump performance curve.
4. Overall (wire to water) efficiency for belt drive pumps shall include losses in the pump, motor, and belt drive.
5. The minimum hydrostatic pressure shall be 1.5 times the shutoff head plus maximum suction pressure.
6. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.015 inch or 1 mil (0.0254 mm) per inch of casing wearing ring diameter, whichever is greater.
7. Pumping units shall be designed so that maximum reverse rotation due to reverse flow at rated head shall not cause damage to any component.

2.03 GENERAL PUMP CONSIDERATIONS

- A. Accurately machine all rotating parts so as to provide dynamically balanced units.
- B. Vibration in excess of the Hydraulics Institute standards shall be sufficient cause for rejection of equipment.
- C. Prevent resonance at normal operating speeds based on mass of unit and its operating speeds.
- D. Constantly increasing head characteristics from design condition to shutoff head.
- E. Capable of operating without overloading electric motor.
- F. Motors designed specifically for connection and operation by motor starter. Starter supplied by Section 46 23 00 equipment supplier.
- G. Motors shall be severe duty, Class 1 Division 1, explosion proof meeting the requirements of Section 26 05 10 .

2.04 GENERAL CONSTRUCTION

- A. The pumps shall be of a fully recessed, slurry type design, with the impeller mounted completely out of the flow path between the pump inlet and discharge connection, so that solids are not required to flow through the impeller. All flow path clearances within the pumps shall be equal to or greater than the discharge diameter, so that all solids which will pass through the discharge will pass through the pump.

- B. Since these pumps will be used to pump abrasive grit and other solids, the pumps shall be specifically designed to both optimize wear resistance and then maintain hydraulic performance as wear occurs.
- C. All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is needed. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness shall not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints shall not be acceptable.
- D. The pump's head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.
- E. Pumps shall be equipped with slotted raised-face flanges to receive 125 lb. standard bolting. Special case slots shall be cast in to retain bolts and to fasten the case to the bearing housing and to the intake for easy case removal.
- F. The lifting handles shall be capable of supporting a load at least 50-percent greater than the wet pump weight.

2.05 MATERIALS

- A. The parts exposed to abrasive wear - case, removable suction piece, impeller, and wearplate shall be of all Ni-Hard or Hi-Chrome Iron material conforming to ASTM Designation A532-75 Class I or Class III, Type A, and be a minimum of 650 Brinell hardness for maximum wear resistance. Brinell values below this are not acceptable.
- B. Test bars shall be cast integrally with the case and suction piece and shall remain attached to the casting upon final delivery to the Owner. Test bars shall be of sufficient thickness to represent the average thickness of the cast part. After receipt of final delivery, the Owner may at any time prior to the final acceptance, remove the test bar and independently verify compliance to the material and hardness specification. Failure of the tested bars to meet the specified requirements shall be cause for rejection.

2.06 CASING

- A. The pump casing shall be either one-piece casting or two-piece radially split type, with a separate and removable suction piece designed so that the impeller can be withdrawn without the need to remove the discharge casing or disturb the discharge piping. The casing shall be constructed so that it can be reversed for opposite rotation and shall be of Ni-Hard or Hi-Chrome Iron. To ensure a liberal

wear allowance, the casing and suction piece shall be constructed, and the entire wet end weights shall be as follows:

Discharge Diameter	Casing Minimum	Suction Piece at Wear Area
3 In.	9/16 In.	7/8 In.
4 In.	5/8 In.	1-1/4 In.
5 In.	3/4 In.	1-1/4 In.
6 In.	3/4 In.	1-1/2 In.

2.07 IMPELLER

- A. The impeller shall be constructed of 650 Brinell Ni-Hard or Hi-Chrome Iron and specifically designed to maintain hydraulic pumping performance as wear occurs.
- B. Main wear to wear element shall be 1-1/8" thick at base, 13/16" thick at tip:
- C. The hydraulic design shall be such that the length of the impeller vane increases as wear occurs to the rim, allowing as-new or better pumping performance throughout the wear cycle of the impeller.
- D. The hydraulic design of the impeller shall preferentially direct flow to an independently replaceable suction piece. The suction piece shall be easily accessible and replaceable, without the need to disassemble any other component of the pump.

2.08 WEAR PLATE

- A. A removable wearplate of Ni-Hard or Hi-Chrome Iron shall be provided behind the impeller designed to direct flow from behind the impeller to the center of the volute for maximum protection to the casing.

2.09 PUMP SHAFT AND SLEEVE

- A. The pump shaft shall be high-strength alloy steel with a minimum 100,000 PSI tensile strength and 75,000 PSI yield strength of sufficient diameter to carry the maximum loads imposed and to prevent vibration and fatigue. The shaft shall be accurately machined along its entire length and precision ground at bearing locations. Keyways shall be provided at both ends. A renewable straight or hook type shaft sleeve, positive adhesive sealed to prevent leakage between the shaft and the sleeve, shall protect the shaft through the sealing box area. The shaft sleeve shall be corrosion resistant bronze or 316 stainless steel with a Brinell hardness of 450 minimum.

2.10 BEARING HOUSING

- A. The bearing housing shall be of cast iron, ASTM A48CL-25 or better and of heavy, rugged design for carrying the bearings and machined for accurate and permanent bearing alignment completely enclosing the shaft between the

bearings. The bearing housing shall be of OSHA approved dust-proof design, incorporating lip-type grease seals in contact with the shaft to prevent the entrance of contaminants. Jacking bolts for external impeller adjustments are required. Zerk-type grease fittings for bearing lubrication shall be supplied at the bearing housings.

2.11 BEARINGS

- A. Provide regreasable radial and axial thrust bearings.
- B. Bearings shall be oil bath lubricated. The oil reservoir shall be sealed at both ends to prevent entrance of foreign matter. The thrust bearings shall consist of three angular contact ball bearings for maximum protection from all thrust loads. The bearing housing shall be equipped with a pressure venting device and oil fill and drain taps. A built-in sight glass shall be furnished to check proper oil level. The bearings shall be rated for a minimum B10 life of 100,000 hours based on calculated loads due to hydraulic thrust at the duty point.

2.12 STUFFING BOX/SEAL HOUSING

- A. The stuffing box shall be constructed of A48 Class 30 cast iron, designed to accommodate:
 - 1. Single mechanical flushless seal designed for no required external flushing.

2.13 MECHANICAL SEALS

- A. A single cartridge mechanical seal requiring no external flushing shall be furnished in the pump. The seal shall utilize a rotational sealing ring mounted in an elastomer cup with an o-ring mounted stationary ring loaded by a non-fouling, conical spring encapsulated in Viton. Installation of the seal shall require no measurements or scribe marks on the shaft.
- B. The rotational sealing ring shall be made of tungsten carbide Grade VC 805 or silicon carbide, the surface of which shall be lapped to a flatness not to exceed three helium light bands. The sealing ring shall be bonded inside a Viton rubber cup, which shall have three (3) integrally molded anti-rotational lugs to prevent the rotary seal face from turning within the rotary body. Additionally, the rotary body shall have three (3) 1/8" solid stainless steel pins to also prevent the rotary seal face from turning within the rotary body.
- C. The stationary sealing ring shall be also be constructed of tungsten carbide Grade VC 805 or silicon carbide. The surface shall be lapped to a flatness not to exceed three helium light bands. The stationary ring shall have a slot milled on the side opposite of the mating side, which engages an anti-rotation

pin. Stationary sealing rings of converted carbon or other surface-only treatments are not acceptable.

- D. The spring that loads the rotational sealing ring shall be cone-type, non-fouling design and shall run in the pumped product without fouling or hang-up. The spring metal material shall be SAE1095 Carbon Steel, ASTM A-682 heat-treated to a Rockwell C hardness of 45 to 50 and be totally encapsulated in Viton for protection from the pumped fluid. The product side of the spring shall have a minimum 1/4" thick Viton rubber covering for corrosion/abrasion protection. Seals which use single coil, multiple coil, bellows and rubber-in-shear designs are not acceptable.
- E. To minimize the number of points where the slurry must be sealed, the mechanical seal assembly shall have no more than three (3) o-rings: one (1) shaft sleeve o-ring, one (1) stationary face o-ring, and one (1) retainer o-ring. O-rings are to be made of Viton. Seals using more than three (3) o-rings are not acceptable.
- F. All metal components not encapsulated in Viton shall be constructed of abrasion-resistant CD4MCu ASTM A-743. Surface finish shall be a maximum of 64 RMS.
- G. The seal shall be capable of running with up to ± 0.025 " radial shaft deflection and ± 0.040 " axial shaft deflection without leakage, damage, or loss of performance.
- H. A seal chamber of Hi-chrome iron, ASTM A-532, minimum 600 Brinell, shall be provided to mount the seal and to provide a reservoir of adequate volume for the pumped product to contact and to lubricate the seal faces. The seal shall be installed into the seal chamber from the impeller side of the pump so that only the casing/suction piece and impeller need to be removed to gain complete access to the seal for inspection and/or maintenance.
- I. Seals requiring a water or product flush shall not be allowed.

2.14 NAMEPLATES

- A. Stainless steel nameplates shall be attached to the pump and drive motor giving the manufacturer's model and serial number, rated capacity, head, speed and all pertinent data.

2.15 PUMP AND MOTOR BASE

- A. Pump and motor shall be horizontally mounted belt driven.
- B. The pump manufacturer shall furnish and install a separate, adjustable motor base with handwheel adjustment so that the motor can be easily moved for V-

belt tensioning and adjustment, TB Woods type MC 3B, modified with a welded steel gusset, or equal.

- C. The pump manufacturer shall supply and install belts and sheaves to drive the pump at the speed necessary to meet the rated conditions.
- D. The drive shall be of the stationary control variable speed TB Woods type 'SVS' or equal, which allows a speed change by means of an adjustment to the motor sheave when the drive is not in operation.
- E. The pump and motor base shall be fabricated from 3/8-inch thick steel, designed to provide rigid support of the pump and motor. Each base shall be furnished with suitable bolt and grout holes to facilitate mounting at site. All seams and contact surfaces between steel shapes and plates of fabricated steel base shall be continuously welded and ground smooth. The base shall be suitable for grouting and bolting to the concrete equipment pad.
- F. Contractor shall coordinate concrete pad sizing for mounting of pedestal base with manufacturer based upon the mounting requirements and the required pump elevation settings.
- G. Design base to resist torsional movement and support weight of pump and motor without deflection while at rest or under load. Suitable corrosion resistant steel OSHA guards are required.
- H. 316 stainless steel coupling guards shall be provided to safely enclose the coupling.
- I. Provide a minimum of four eye hooks for lifting equipment during shipping and installation.

2.16 MOTORS

- A. Motors shall be sized so they are not loaded above full load rating at any point on the impeller operating curve. Operation in the motor "service factor" range is not acceptable.
- B. Minimum motor efficiency shall be minimum 94% at 75% and 100% motor loads and 93% at 50% motor load.
- C. Motors shall be suitable for 460 VAC, 3 phase, 60 HZ operating power, totally enclosed fan cooled (TEFC), meeting the requirements of Section 26 05 10 . The motors shall be suitable for inverter duty. Maximum power required by the pump in the operating head range shall not exceed 90 percent of the motor nameplate rating. Motors shall be equipped with thermal overload protection capable of tripping associated motor starter and then resetting automatically after cool down.

- D. Motors shall be specifically selected for service with a motor starter.
- E. The pump and motor shall be rated for continuous duty.
- F. A heat sensor thermostat shall be attached to motor winding and shall be connected to the motor starter to stop motor if motor winding temperature reaches 250°F. Thermostat to reset automatically when motor cools. Two heat sensors are to be used on three-phase motors.
- G. Motors shall be in accordance with the requirements of Division 26.

2.17 ANCHOR BOLTS AND FASTENERS

- A. Contractor shall provide anchor bolts of ample size and strength required to securely anchor each item of equipment in accordance with equipment manufacturer's requirements. Anchor bolts shall be long enough to accommodate a minimum of 1.5 inches (38.1 mm) of grout beneath the baseplate. Bolts, washers and hex nuts shall be AISI Type 304 stainless steel unless noted otherwise.
- B. Anchor bolts shall be set by the Contractor using templates provided by the equipment manufacturer. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.
- C. Anchor bolts shall be accurately located and centered between pipe sleeves having an inside diameter approximately 2.5 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with a thickness of approximately half the bolt diameter and side dimension of 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be furnished with each bolt.

2.18 FACTORY SURFACE PREPARATION AND PAINTING

- A. All surfaces of the pumps, other than stainless steel and hot dip galvanized steel, shall be protected by a two-component epoxy coating.
- B. Electric motors, speed reducers, and other self-contained or enclosed components shall have the original manufacturer's standard enamel finish.
- C. Apply rust preventative compound to all machined, polished, and nonferrous surfaces that are not to be painted.
- D. All material and equipment in this section shall be factory primed. Primer shall be compatible with finish coats of paint provided below.
- E. High Performance Coating Materials:

1. Materials specified herein are the only approved standard coating systems unless an "or equal" is proposed in accordance with the Contract Documents and Specifications and approved in writing by the Engineer.
 2. Surface Preparation: SSPC SP 6 for steel and in accordance with manufacturer's instructions for other surfaces.
 - a. Primer: Series N69 Hi-Build Epoxoline II 3.0 – 5.0 Dry Film-Mils
 - b. 1st Coat: Series N69 Hi-Build Epoxoline II:4.0 – 6.0 Dry Film Mils
 3. At least 1 quart of the finish coat material shall be furnished with each pump for field touch-up.
- F. The finishing of painting of all materials and equipment in this Section that are not concealed shall be the responsibility of the Installation Contractor. The Contractor shall, however, refinish and restore to the original appearance, all equipment that has sustained damage to the manufacturer's finish or prime coat of paint or enamel.
- G. All areas to be painted shall be free of debris.
- H. Approved Manufacturers
1. Tnemec
 2. Sherwin Williams

2.19 SPARE PARTS

- A. Furnish lubricating materials to allow for one year of operation. Lubricating materials shall be as recommended by the manufacturer.
- B. Furnish the following spare parts:
1. One set of flushless mechanical seals.
 2. One set of wear rings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations.
- B. Systems to be installed complete with all necessary connections, valves, pipes, and fittings.
- C. Contractor responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.
- D. Contractor shall complete all electrical power and control connections as specified in Division 26.

- E. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of significant deviations.

3.02 STARTING AND ADJUSTING

A. Manufacturer's Service

1. Provide services of an experienced, competent and authorized representative of manufacturer for a minimum of eight (8) hours. Additional Manufacturer services for starting and adjusting shall be the responsibility of the Contractor.
2. Reference Division 01 for additional requirements.

3.03 COMMISSIONING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.
- B. Test shall be conducted on each of the pumps, individually. The test shall be to verify proper operation of the pumping unit and shall include operating the pump at different flows and pressures, and different speeds over the operating range. The final part of the test shall be to operate the pump at design flow for a minimum of 15 minutes without a shutdown. The Manufacturer's representative shall be present and approve the complete testing operational procedure. Testing shall not be conducted until all pumping equipment, drives, piping and valves, and supporting systems, including controls, and related work, has been completed. The Contractor shall be responsible for scheduling and providing all materials and equipment necessary to conduct the test. This shall include providing and installing temporary facilities if required.
- C. Performance test shall be conducted as part of facility startup and performance evaluation. Testing shall be under actual conditions. Pumps shall be tested individually across the entire range of flow and pressure as specified. Performance testing of pumps shall include the use of variable frequency drives. Testing shall be done per H.I. Standards. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency for capacity from shutoff to 150% of design flow. A minimum of five points, including shutoff, shall be taken for each test run. At least one point of the five shall be taken as near as possible to each specified condition.

3.04 CLASSROOM AND DEMONSTRATION TRAINING

- A. Provide a minimum four (4) hours of classroom training and four (4) hours of demonstration training by a qualified manufacturer's representative.

- B. Contractor shall record training via digital video camera so Owner can use again in the future.
- C. Contractor shall meet additional requirements as required in Section 01 79 00.

END OF SECTION 43 21 14

SECTION 43 22 70
AUTOMATIC SAMPLER

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Furnishing and installation of the following, as indicated, in accordance with the provision of the Contract Documents:
 - a. Automatic Sampler.
 - b. Prefabricated metal enclosure for sampler.

B. Related Sections include:

1. Section 40 27 00 - Process Piping - General .
2. Section 40 27 05 - Process Piping Support Systems .
3. Section 40 27 20 - Process Valves .
4. Section 40 42 13 - Process Piping Insulation and Heat Tracing .

1.02 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00. In general, include detailed data covering specifications, drawings, materials, parts, motors, sizes, capacities, dimensions, weights, lifting points, parts list, spare parts, clearance distances, wiring diagrams, controls, and other accessories forming part of equipment for the complete operational system.
- B. Furnish Manufacturer's field service reports under provisions of Section 01 33 00, reports covering start up, adjusting, commissioning, demonstration, and training.
- C. Submit operation and maintenance manuals and Manufacturer's instructions in accordance with Sections 01 33 00 and 01 78 23.
- D. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.03 SYSTEM DESCRIPTION

- A. One (1) automatic refrigerated wastewater samplers shall be furnished.
- B. One (1) prefabricated metal enclosures shall be furnished.

- C. Sampler shall be located at the Diversion Manhole for taking samples from the influent channel

PART 2 - PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. ISCO, Model No. 5800
- B. Or Equal

2.02 SAMPLER

- A. One (1) automatic refrigerated wastewater sampler shall be furnished for sequential and composite sampling applications, suitable for indoor or outdoor installation without the requirements for additional enclosures for weather protection. The sampler shall be capable of collecting samples from a variety of liquid sources including open channels, sewers, and storm water conduits. The sampler shall route samples to storage containers for collection and off-site analysis. The sampler shall be suited to collect priority pollutant or general purpose samples in multiple bottles or a single bottle. The unit shall be line (AC) powered 120 volt 60Hz via local receptacle.

2.03 REFRIGERATOR

- A. The shell of the refrigerator shall be constructed of rotationally molded UV-resistant lineal low density polyethylene (LLDPE) with molded-in-place thermal insulation, providing exceptional resistance to corrosion and weathering. The top of the refrigerator door shall be recessed for ease of access from above. For 24 bottle configurations, the bottle rack shall slide out for ease of sample recovery. The copper refrigeration lines, condenser coil, and evaporator plate shall be powder-coated with heat-treated polyester for additional corrosion resistance. The refrigerant used shall be a non-CFC refrigerant with an ozone depletion potential of zero.
- B. The refrigerator's door shall have hasps capable of accepting a padlock to prevent unauthorized tampering with the sample compartment contents. A compression gasket shall be used to seal the refrigerator door. The refrigerator power supply and solid-state thermostat shall be contained in an epoxy-potted enclosure housed in a separate pocket of the sampler's molded frame. All exposed metal components used in the construction of the refrigeration system shall be either plated aluminum or stainless steel.
- C. The unit shall include long-life electronic temperature sensing devices that shall measure the refrigeration compartment and evaporator plate temperatures. A microprocessor shall utilize this sensor to control operation of the compressor, built-in heaters, and the self-defrosting cycle of the evaporator plate. The built-in

heaters shall prevent collected samples from freezing if the ambient air temperature drops below freezing.

- D. The sampler shall not require a separate heater for the controller. The sampler shall use a condensing coil with forced-air cooling. The current refrigeration temperature shall appear on the sampler's display, and temperature readings shall be stored in a report.
- E. The refrigerator shall use a compressor rated at 1/5 Hp for 120V. The compressor shall be equipped with a temperature safety cutout that will disengage the compressor if a temperature of 221°F (105°C) is reached. The refrigeration system shall contain HFC-134a as the refrigerant. The refrigerator shall have a 5 minute typical recovery time to return to 39°F (4°C) after the door has been opened for 1 minute in 75°F (24°C) ambient conditions. The collected samples shall be stored in an enclosure capable of operating in ambient temperatures from -20° to 120°F.
- F. The refrigerator shall, upon program initiation, drop the temperature within the sample compartment by 2.5° C below the set temperature for the first 24 hours of operation before resuming normal operation.
- G. The top section housing the control panel, pump, distributor electronics, and power supply box shall be NEMA rated at 4X, 6, and IP 67.

2.04 CONTROLLER

- A. The controller shall be housed in a separate pocket of the sampler's molded frame beneath a flip cover. The controller shall use a 2 row, 20 column, 40 total character display to show sampler status and program information. This display shall be angled for easy viewing and backlit for easy use in all light conditions. An 18 position keypad shall be used for all program entries and manual control of the sampler.
- B. The sampler's memory shall maintain the program settings, stored programs, and the results of the last sampling sequence when the sampler is turned off or an external power interruption occurs. A user-initiated diagnostics routine shall determine the operational status of the sampler. Any error conditions detected by the diagnostic routines shall be displayed to the user.
- C. Provide manufacturer's 16 wire cable (25-feet minimum length). Cable shall contain manufacturer's connector on one end to connect to the sampler and no connector on the other end that will land in a Contractor provided terminal block.
- D. The user can define specific program operational parameters. The user can program the sampler to collect sequential or composite samples at user-definable intervals and volumes. A delay to first sample collection shall be programmable by the real-time clock, if desired.

1. The sampler shall use an internal real-time clock to provide time and date information. Uniform time-paced samples shall be collected at regular time intervals from 1 minute to 99 hours 59 minutes. Sample volumes may be equal, or variable in proportion to flow.
2. The sampler shall accept a 5 to 15 VDC flow proportional pulse or isolated dry contact closure from an external flow meter. The pulse or contact closure shall be at least 25 ms in duration. Samples shall be taken at equal time intervals, and variable sample volumes shall be proportional to cumulative flow.
3. The sampler shall have a standard 4-20 mA flow proportional input compatible with most flow meters without additional interfacing. Samples shall be taken at equal time intervals, and variable sample volumes shall be proportional to cumulative flow.

E. Sampler Input/Outputs

1. The sampler shall have four standard digital alarm outputs capable of direct wiring to a Programmable Logic Controller (PLC) or data logger (5 volt, 100 mA).
2. Output alarms shall include: Program started, Program completed, Pump error, Distributor jammed, 3-way valve control, Taking sample, Pumping forward, Pumping reverse, Powered up, Bottle full, and Delay before sample.
3. Sampler shall accept a 5 to 15 VDC flow proportional pulse or 4-20 mA signal from flow meter.

2.05 SAMPLE DELIVERY

- A. The sampler program shall allow the user to select from 3 types of sample distribution: samples per bottle, bottles per sample, and multiple bottle compositing. In the samples per bottle mode, a minimum of 15 samples shall be capable of being deposited in each sample container. In the bottles per sample mode all sample bottles shall be capable of being filled with a single initiation. Multiple bottle compositing shall allow the user to simultaneously create a pair or set of bottles containing multiple samples. The sampler shall switch bottles after a period of time has elapsed, or a predetermined number of samples has been collected.
- B. Samples shall be collected using a peristaltic pump. This pump shall produce typical line velocities of 3.0 feet (91.44 cm) per second in a 3/8 inch (9.52 mm) ID suction line at 3 feet (91.44 cm) of head. At 25 feet (762 cm) of head, the pump shall typically produce a line velocity of 2.2 feet (67.06 cm) per second. The pump shall be capable of lifting a sample a maximum of 28 feet (853.44 cm).
 1. The body of the peristaltic pump shall be housed in a separate pocket of the sampler's molded frame, beneath a latched cover. The pump shall be

- constructed of high strength Noryl® plastic and designed for corrosion resistance.
2. Before and after each sample is collected, the pump shall air-purge the suction line. Pre-purges and post-purges shall be automatically controlled, and no pre-calibration adjustments are required.
 3. The pump shall include an optional heater, housed beneath the pump cover, for the prevention of liquid freezing inside the pump under extremely cold conditions. A heater shall be available for the 115VAC sampler.
- C. The sampler shall typically deliver sample volumes with an accuracy of ± 10 ml or $\pm 10\%$, whichever is greater, of the programmed value. The sample volume repeatability shall be ± 5 ml or $\pm 5\%$, whichever is greater, of the average of the maximum and minimum sample volume in the sample set. The user can select sample volumes from 10 to 9,990 ml in 1 ml increments. Additionally, the sampler shall be capable of being programmed to rinse the suction line with the source liquid up to three times.
- D. The sampler shall utilize a non-wetted, non-conductive detector to sense the presence of the liquid. The sensor shall not be dependent on, or affected by, any chemical or physical property of the liquid or its contents. The sensor shall not require routine maintenance or cleaning. The liquid detection system shall minimize the effects of changing head, intermittent flow in the suction line, or variable battery conditions on sample volume. After initial detection of liquid, the sensor shall monitor for the presence of liquid during the sample collection sequence, allowing for full bottle detection in composite mode.
- E. After liquid detection, the pump revolution counter shall count actual pump revolutions to determine sample volume delivery to the storage containers. If liquid flow is interrupted during the sample collection sequence, the detector shall inhibit the pump revolution counter from incrementing until liquid flow is restored. Automatic compensations for air slugs in the sample shall be made by the delivery system. Additionally, the pump revolution counter shall monitor the total number of pump revolutions and alert the user when a pre-selected number of counts has been reached. This tubing life indicator shall alert the user to the need for pump tubing replacement. This indicator shall be on the sampler's display screen. The pump tubing used shall be specially treated to minimize water extractable pollutants. Specially designed bands shall indicate the correct placement of the tubing inside the pump. The tubing shall typically last for a minimum of 1,000,000 pump counts. One pump revolution is equivalent to 12 pump counts.
- F. The distributor shall be housed in a separate pocket of the refrigerator's molded frame. Sample distribution shall be belt-driven by a stepper motor. An optical sensor shall be used for positive location of the distributor arm. A single

adjustable distributor arm shall be used for all bottle configurations and sampler mounting possibilities. The distributor arm may be moved by hand for ease of sample recovery, and will relocate itself before the next sample is taken.

2.06 SUCTION LINES AND STRAINERS

- A. The sampler shall require a suction line and strainer. The suction line shall be made of 3/8 inch (9.52 mm) ID PTFE vinyl] with a length of 50 feet (1524 cm). The suction line shall have a factory installed standard 3/8" weighted polypropylene strainer.

2.07 SAMPLE COLLECTION CONTAINERS

- A. Each sampler shall be supplied with sample collection container(s). The container(s) shall be one set for each sampler :
 - 1. 2 round 10L polyethylene

2.08 PREFABRICATED METAL ENCLOSURES

- A. Enclosures shall be galvanized steel, Newburgh Style 6-foot by 5-foot steel storage shed, Model #NW65, Arrow shed manufactured by Shelter Logic, or approved equal.
- B. Enclosures shall be equipped with sliding doors with locking hasps, minimum opening width of 32-inches, and minimum total storage area of 27 sq ft.
- C. Provide concrete anchors.
- D. Provide 12-year warranty with each enclosure.

2.09 SPARE PARTS

- A. 10 pump tubes (shall be stored in plastic bags out of sunlight)
- B. 3/8-inch x100-feet vinyl suction line
- C. 10 feet (304.8 cm) discharge tubing
- D. One (1) pump assembly

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install samplers in accordance with manufacturer's recommendations at locations indicated on the Construction Drawings.
- B. Systems to be installed complete with all necessary connections, valves, pipes, and fittings.

- C. Contractor responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.
- D. See Section 46 05 01 for additional requirements.
- E. Contractor shall complete all electrical power and control connections as specified in Division 26 and coordinate power and control wiring with electrical contractor.

3.02 STARTING AND ADJUSTING

- A. Manufacturer's Service
 - 1. Provide services of an experienced, competent and authorized representative of Manufacturer for a minimum of eight (8) hours. Additional Manufacturer services for starting and adjusting shall be the responsibility of the Contractor.
 - 2. Reference Sections 01 45 00, 01 75 00 and 46 05 01 for additional requirements.

3.03 COMMISSIONING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.

3.04 CLASSROOM AND DEMONSTRATION TRAINING

- A. Provide minimum four (4) hours of classroom training and four (4) hours of demonstration training by a qualified manufacturer's representative.
- B. Contractor shall record training via digital video camera so Owner can use again in the future.
- C. Contractor shall meet additional requirements as required in Section 01 79 00.

END OF SECTION 43 22 70

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SECTION 43 25 13
SUBMERSIBLE WET PIT SEWAGE PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Contractor shall furnish and install the following equipment in accordance with the provisions of the Contract Documents:
 - a. Two (2) explosion-proof, semi-permanent, submersible non-clog centrifugal wet pit sewage pumps in duplex configuration for the Backwash Lift Station location shown on the Drawings.
 - b. Two (2) explosion-proof, semi-permanent, submersible non-clog centrifugal wet pit sewage pumps in duplex configuration for the Decant Lift Station location shown on the Drawings.
 - c. One (1) explosion-proof, semi-permanent, submersible non-clog centrifugal wet pit sewage pump for the SBR Waste Activated Sludge location shown on the Drawings.
2. Contractor shall coordinate wetwell pump and pipe spacing, access hatch dimensions and orientations, guide rails, electrical, controls and related appurtenance to accommodate future pumps as defined in this specification.

B. Related Sections include:

1. Section 01 33 00 - Submittal Procedures .
2. Section 01 45 00 - Quality Control .
3. Section 01 61 00 - Common Product Requirements .
4. Section 01 75 00 - Starting and Adjusting .
5. Section 01 77 00 - Closeout Procedures .
6. Section 01 78 23 - Operation and Maintenance Data .
7. Section 08 31 00 - Floor Access Hatches
8. Section 09 90 02 - High Performance Painting and Coating .
9. Division 26 – Electrical.
10. Section 40 27 00 - Process Piping - General.
11. Section 40 27 10 - Process Piping Specialties .
12. Section 40 27 20 - Process Valves .

1.02 REFERENCES

A. Reference Standards:

1. HI – Hydraulic Institute Standards.
2. ABMA – American Bearing Manufacturers' Association
3. AGMA – American Gear Manufacturers' Association

4. ASME – American Society of Mechanical Engineers
5. ASTM – American Society for Testing and Materials.
6. AISI – American Iron and Steel Institute.
7. ANSI – American National Standards Institute.
8. AWWA - American Water Works Association.
9. NEC – National Electrical Code
10. NEMA – National Electrical Manufacturer's Association

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00, detailed specifications, drawings, clearance distances, dimensions, weights, lifting points, wiring diagrams, pump curves, certified test results, and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.
- B. Pumps
 1. Name of manufacturer.
 2. Type of model.
 3. Design rotative speed.
 4. Type of pump bearings.
 5. Size of shafting.
 6. OD of impeller.
 7. Weight of complete assembly, including motor.
 8. Type of seals.
 9. Material of component construction.
 10. Lift out rail system details.
 11. Access opening requirements for simplex and duplex pump installation as shown on Construction Drawings.
- C. Provide certified performance curves for each pump, including capacity, head, NPSH requirement, efficiency and BHP requirements. Curves shall be approved by Engineer before shipping pumps. Pumps that do not meet performance curve requirements will not be acceptable. Pump performance shall be calculated according to manufacturer's published standards.
- D. Manufacturer's Instructions: Furnish under provisions of Section 01 33 00.
- E. Manufacturer's Field Service Reports: Furnish, under provisions of Section 01 75 00, reports covering start up, demonstration, and instructions.
- F. Operations and Maintenance Data: Submit in accordance with Section 01 78 23 on all parts, devices, equipment, and other accessories furnished forming the complete operational system. Include a complete write-up of how the system is to operate and be maintained and how to make adjustments and repairs.

- G. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.04 SYSTEM DESCRIPTION

- A. Provide submersible wet pit, non-clog, end suction centrifugal sewage pumping units and controls as indicated herein and on the drawings.
- B. Each pumping unit shall be complete with a close-coupled, explosion-proof, submersible high/premium efficiency electric motor suitable for wet pit, bottom-end suction application and using pedestal base, a non-sparking guide rail and self-connecting, pedestal-mounted discharge base elbow assembly system for installation without confined space entry, electrical cables, lifting hooks, controls and all other appurtenances specified, or otherwise required for proper operation. The guide rail and base elbow assembly shall be non-sparking, approved for Factory Mutual use in NEC Class 1, Division 1, Group C & D environments and compatible with pumps of any manufacturer, having standard 4-inch ANSI class 125 pump discharge flanges.
- C. Pumps shall be submersible, rated for continuous duty, while completely or partially submerged using the process fluid for self-cooling, at the specified operations points, and shall be provided complete with all accessories, float switches, controls and appurtenances as required for a complete operating system.
- D. Pump motors shall be high efficiency, inverter-duty rated.

1.05 QUALITY ASSURANCE

- A. The equipment supplier must have at least five continuous years experience in the design, application and manufacture of submersible non-clog wet pit sewage pump assemblies of similar size and capacity. All material and equipment shall be new and of the highest quality.
- B. Pumps, complete with motor, power cable, float switches and cables, stainless steel lifting hoop and lifting chain, non-sparking guide rail and discharge base elbow assembly, and all other specified accessories and appurtenances shall be furnished by the pump manufacturer to ensure compatibility and integrity of the individual components, and provide the specified warranty for all components.
- C. In order to assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these specifications that all submersible wet pit sewage pump system assemblies and accessories called for under this section shall be

supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.

- D. Drawing layouts, item weights and specification language for the submersible pumps are based on Sulzer. Modifications, including but not limited to, process, mechanical, electrical, controls and structural required for other approved Manufacturer's equipment may be necessary and shall be included in the Contractor's bid price.
- E. The Contract Documents represent the minimum acceptable standards for the equipment for this project. Equipment shall conform fully in every respect to the requirements of the respective parts and sections of the Construction Documents. Manufacturer's shall modify, redesign, and furnish with special features or accessories, use materials or provide equipment with finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of this specification.
- F. Balance. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including top of motor, shall not exceed the maximum velocity as indicated for vertical, end suction, solids handling pumps in Figure 9.6.4.10 of the governing standard (HI).
- G. Coordinate all items with precast concrete supplier.

1.06 FACTORY TESTING

- A. Pumps shall be factory tested as a complete pumping unit. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at rated head, shutoff head, operating head extremes, and at as many other points necessary for accurate performance curve plotting. Testing shall conform to the Standards of the Hydraulic Institute.
- B. Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, bhp brake kW, pump efficiency, and shop test NPSH available, plotted against capacity. The curves

shall be easily read and plotted to scales consistent with performance requirements. All test points shall be clearly shown.

1.07 DELIVERY STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the OWNER until required for installation. Materials shall be stored in accordance with manufacturer's instructions.
- B. CONTRACTOR shall inspect materials upon delivery for loss or damage in transit. CONTRACTOR shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.

1.08 WARRANTY REQUIREMENTS

- A. The equipment manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a minimum period of five (5) years, pro-rated after two years, under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty.
- B. Warranty shall commence after completion of the performance and operation testing or after written acceptance of the installation by Engineer, whichever occurs earlier.

1.09 MAINTENANCE AND SERVICE

- A. Manufacturer's authorized representative shall have his own full time repair service available on 24-hour call.
- B. A factory serviceperson and service vehicle equipped with tools to make all necessary repairs, as well as component parts required to maintain satisfactory operation of the equipment outlined in these specifications, shall be available if needed, without undue delay.
- C. Representatives shall maintain a local stock of parts for each model of pump bid.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Submersible Wet Pit Sewage Pumps:
 - 1. Sulzer XFP80C-VX-60HZ (Backwash Lift Station Pumps and WAS Pump)
 - 2. Sulzer XFP206J-CB2-60HZ (Decant Lift Station Pumps)
 - 3. Approved Equal

4. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section. Any deviations without sufficient evidence proving equal or superior quality shall be rejected without further review or comment.

2.02 SYSTEM DESIGN

A. Backwash Lift Station Pumps (BLP-001, BLP-002)

1. Service Conditions:

- a. Two (2) new vortex submersible sewage pumps shall be installed in the new Backwash Lift Station. Unit(s) will pump backwash water from the Fuzzy Filter, scum from the Clariflocculator, decant from the aerobic digester, and overflow from the bypass pond through approximately 280 lineal feet of 4-inch diameter HDPE force main to a new sewer manhole carrying PTB influent. Each pump unit will generally operate alone, although installed in parallel configuration with each other. Lead-lag alternation will be used in control strategy. Desired design flow range with pump speed adjustment, from approximately 100 gpm with one pump running to approximately 200 gpm with two pumps running. The equipment provided under this section shall be suitable for the following service conditions:
 - 1) Maximum Liquid Temperature: 104 degrees Fahrenheit (40 degrees Celsius)
 - 2) Pumps start and stop against closed swing check valve

2. Performance and Design Requirements:

- a. Pumping units shall be designed for following performance and design requirements:

Location/Purpose	Backwash Lift Station Pumps
Cooling Jacket	No
Number of Pumps	2
Speed Control	N/A
Type	Non-Clog
Minimum Horsepower	4
Minimum Sphere Size (in.)	3
60Hz Total Dynamic Head (ft)	19
60Hz DesignFlow (gpm)	100
Minimum Required Shutoff Head (ft)	27
Maximum Nominal Pump Speed (rpm)	1800

Minimum Efficiency at Rated Head, (%)	29
Minimum NPSHA at Rated Head (ft)	25
Top of Wet Well Base Slab Elev. (ft)	4932.0
High Water Level Elev. (ft)	4938.25
Low Water Level Elev. (ft)	4933.25
Maximum Force Main Elevation (ft)	4947.61
Minimum Pump Suction Size (in.)	4
Minimum Pump Discharge Size (in.)	4

- b. All specified conditions shall be at rated speed unless otherwise noted.
- c. Pumps operating at 1150 to 1800 RPMs are acceptable. Pumps operating at RPMs above 1800 RPMs will not be acceptable.
- d. Pumps shall be non-overloading of the motor, excluding service factor, throughout the entire pump performance curve.
- e. Overall (wire to water) efficiency for variable speed pumps shall include losses in the pump, motor, variable frequency drive, and any transformers supplied as part of the variable frequency drive equipment.
- f. The minimum hydrostatic pressure rating shall be 1.5 times the shutoff head plus maximum suction pressure.
- g. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.015 inch or 1 mil (0.0254 mm) per inch of casing wearing ring diameter, whichever is greater.
- h. Pumping units shall be designed so that maximum reverse rotation due to reverse flow at rated head will not cause damage to any component.

B. SBR Decant Lift Station Pumps (SBR2-SDP-001, SBR2-SDP-002)

1. Service Conditions:

- a. Two (2) new two-vane ContraBlock Evo impeller submersible sewage pumps shall be installed in the new Decant Lift Station. Unit(s) will pump treated wastewater decanted from the new SBR through approximately 120 lineal feet of 10-inch diameter PVC force main to tie in to an existing sewer line to the Flow Leveling Basing at a length of approximately 300 feet and Clarifloculator in the Plant Building. Each pump unit will generally operate alone, although installed in parallel configuration with each other. Lead-lag alternation will be used in control strategy. Desired design

flow range with pump speed adjustment, from approximately 1,780 gpm with one pump running to approximately 2,400 gpm with two pumps running. The equipment provided under this section shall be suitable for the following service conditions:

- 1) Maximum Liquid Temperature: 104 degrees Fahrenheit (40 degrees Celsius)
- 2) Pumps start and stop against closed swing check valve

2. Performance and Design Requirements:

- a. Pumping units shall be designed for following performance and design requirements:

Location/Purpose	SBR Decant Lift Station Pumps
Cooling Jacket	Yes
Number of Pumps	2
Speed Control	Variable Frequency Drive
Type	Non-Clog
Minimum Horsepower	30
Minimum Sphere Size (in.)	2.95
60Hz Design Flow Total	35
Dynamic Head (ft)	1670
60Hz Design Flow (gpm)	45
Minimum Required Shutoff Head (ft)	900
Maximum Nominal Pump Speed (rpm)	78
Minimum Efficiency at Rated Head, (%)	25
Minimum NPSHA at Rated Head (ft)	4928.50
Top of Wet Well Base Slab Elev. (ft)	4937.32
High Water Level Elev. (ft)	4931.00
Low Water Level Elev. (ft)	4950.3
Maximum Force Main Elevation (ft)	8
Minimum Pump Suction Size (in.)	8
Minimum Pump Discharge Size (in.)	

- b. All specified conditions shall be at rated speed unless otherwise noted.
- c. Pumps shall be non-overloading of the motor, excluding service factor, throughout the entire pump performance curve.

- d. Overall (wire to water) efficiency for variable speed pumps shall include losses in the pump, motor, variable frequency drive, and any transformers supplied as part of the variable frequency drive equipment.
- e. The minimum hydrostatic pressure rating shall be 1.5 times the shutoff head plus maximum suction pressure.
- f. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.015 inch or 1 mil (0.0254 mm) per inch of casing wearing ring diameter, whichever is greater.
- g. Pumping units shall be designed so that maximum reverse rotation due to reverse flow at rated head will not cause damage to any component.

C. SBR Waste Activated Sludge Pump (SBR2-WAS-001)

1. Service Conditions:

- a. One (1) new vortex impeller submersible sewage pumps shall be installed in the new SBR. Unit(s) will pump sludge from the new SBR through approximately 90 lineal feet of 4-inch diameter DI force main and approximately 150 lineal feet of 4-inch PVC to the Aerobic Digester in the Plant Building. Desired design flow range with pump speed adjustment, from approximately 110 gpm to approximately 125 gpm. The equipment provided under this section shall be suitable for the following service conditions:
 - 1) Maximum Liquid Temperature: 104 degrees Fahrenheit (40 degrees Celsius)

2. Performance and Design Requirements:

- a. Pumping units shall be designed for following performance and design requirements:

Location/Purpose	SBR Waste Activated Sludge Pump
Cooling Jacket	No
Number of Pumps	1
Speed Control	N/A
Type	Non-Clog
Minimum Horsepower	4
Minimum Sphere Size (in.)	3
60Hz Design Flow Total Dynamic Head (ft)	10
60Hz Design Flow (gpm)	127
Minimum Required Shutoff Head (ft)	14
Maximum Nominal Pump Speed (rpm)	1,800

Minimum Efficiency at Rated Head, (%)	21
Minimum NPSHA at Rated Head (ft)	35
Top of SBR Base Slab Elev. (ft)	4928.50
High Water Level Elev. (ft)	4943.00
Low Water Level Elev. (ft)	4939.17
Maximum Force Main Elevation (ft)	4944.88
Minimum Pump Suction Size (in.)	4
Minimum Pump Discharge Size (in.)	4

- b. Pumps operating at 1150 to 1800 RPMs are acceptable. Pumps operating at RPMs above 1800 RPMs will not be acceptable.
- c. All specified conditions shall be at rated speed unless otherwise noted.
- d. Pumps shall be non-overloading of the motor, excluding service factor, throughout the entire pump performance curve.
- e. Overall (wire to water) efficiency for variable speed pumps shall include losses in the pump, motor, variable frequency drive, and any transformers supplied as part of the variable frequency drive equipment.
- f. The minimum hydrostatic pressure rating shall be 1.5 times the shutoff head plus maximum suction pressure.
- g. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at minimum suction submergences. The design running clearance between the impeller inlet and the casing wearing ring (if provided) shall be not less than 0.015 inch or 1 mil (0.0254 mm) per inch of casing wearing ring diameter, whichever is greater.
- h. Pumping units shall be designed so that maximum reverse rotation due to reverse flow at rated head will not cause damage to any component.

2.03 GENERAL PUMP CONSIDERATIONS

- A. Accurately machine all rotating parts to provide dynamically balanced units.
- B. Vibration in excess of the Hydraulic Institute standards shall be sufficient cause for rejection of equipment.
- C. Prevent resonance at normal operating speeds based no mass of unit and its operating speeds.
- D. Constantly increasing head characteristics from design condition to shutoff head.
- E. Capable of operating without overloading electric motor or VFD drive.

- F. Motors designed specifically for connection and operation by VFD.
- G. Motors shall be inverter-duty rated with thermal winding switches.
- H. All equipment locating in wet wells shall meet National Electric Code (NEC) requirements for Class 1, Division 1, Group D locations.

2.04 CONSTRUCTION

- A. Non-Clog: Pumps shall be centrifugal, non-clog, solids handling, submersible, explosion proof wastewater type pumps capable of handling raw unscreened wastewater and passing a nominal 3-inch sphere.
- B. The stator housing, oil or air chamber housing, and seal housing shall be high quality grey cast iron, ASTM A48, Class 35B. All external mating surfaces shall be machined and Buna N Rubber o-ring sealed. All fasteners exposed to the pumped liquids shall be 316 stainless steel.
- C. The pump shall be provided with an oil chamber for the shaft sealing system. The drain and inspection plug, with positive anti leak seal, shall be easily accessible from the outside.
- D. All mating surfaces of major components shall be machined and fitted with O-rings where watertight sealing is needed. Sealing shall be accomplished by O-ring contact on four surfaces and O-ring compression in two planes, without reliance on a specific fastener torque or tension to obtain a watertight joint. The use of elliptical O-rings, gaskets, or seals requiring a specific fastener torque value to obtain and maintain compression and watertightness will not be acceptable. The use of secondary sealing compounds, gasket cement, grease, or other devices to obtain watertight joints will not be acceptable.
- E. The lifting hoop shall be stainless steel rated for a minimum of three times the weight of the pump with the volute containing water. The working load rating of the lifting system shall be a minimum of 50 percent greater than the weight of the pump with the volute full of water.
- F. The guide rail and base elbow assembly shall be non-sparking, approved for Factory Mutual use in NEC Class 1, Division 1, Group C & D environments and compatible with pumps of any manufacturer, having standard ANSI class 125 pump discharge flanges.
- G. The pump's head vs. capacity curve shall slope upward toward shutoff in one continuous curve with no points of inflection capable of causing hunting at any pump operational speed.

2.05 VOLUTE

- A. Non-Clog Volute: The pump volute (casing) shall be of A48 Class 35B gray cast iron and shall have an integral spiral shaped cast groove(s) at the suction of the volute. The internal volute bottom or insert ring shall provide effective sealing between the pump volute and the enclosed or semi-open impeller. The sharp spiral groove(s) shall provide the shearing edge(s) across which each impeller vane leading edge shall cross during its rotation in order to remain unobstructed. The clearance between the internal volute bottom and the impeller leading edges shall be adjustable.
- B. The discharge nozzle shall be flanged, with dimensions and drilling conforming to ANSI B16.1, Class 125, and compatible with the guide rail and self-connecting base elbow assembly.

2.06 IMPELLER (SEMI-OPEN)

- A. Non-Clog Impellor: The impeller(s) shall be of gray cast iron, ASTM A48, Class 35B, enclosed one-piece casting, dynamically balanced, semi-open, single or multi-vane, backswept, non-clog design.
- B. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a spiral groove located on the volute suction which shall keep them clear of debris, maintaining an unobstructed leading edge. The impeller(s) vanes shall have hardened leading edges and shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. Impellers shall be locked to the shaft by means of a key and self locking nut or bolt and shall be coated with alkyl resin primer.
- C. The impeller vane leading edges shall be mechanically self-cleaned upon each rotation as they pass across a spiral groove located on the volute suction which shall keep them clear of debris, maintaining an unobstructed leading edge. The impellers(s) vanes shall have screw-shaped leading edges that are hardened to RC54 and shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in wastewater. The screw shape of the impeller inlet shall provide an inducing effect for the handling of rag-laden wastewater.

2.07 WEAR PLATE (SEMI-OPEN IMPELLERS)

- A. An axially-adjustable, self-cleaning wearing plate shall be provided for semi-open type impellers and arranged to permit adjustment of the axial running clearance between the impeller and plate. The wearing plate shall have an outward spiraling groove designed to assist in shredding and forcing stringy solids outward and away from the impeller.
- B. Wearing plate shall be Cast iron, Class 35B.

2.08 SHAFTS

- A. Pump and motor shaft shall be a solid continuous shaft. The pump shaft shall be an extension of the motor shaft and shall have a torque rating for full shutoff head safety factor of 1.7.
- B. The pump shaft shall be alloy steel, hard chrome plated; or martensitic steel AISI Type 416 or 420.

2.09 BEARINGS

- A. The pump shaft shall rotate on at least two grease-lubricated bearings. The upper bearing, provided for radial forces, shall be a single roller bearing. The lower bearing shall consist of at least one roller bearing for radial forces and two angular contact ball bearings for axial thrust.
- B. The pump bearings shall have a L10 bearing life of a minimum of 100,000 hours.

2.10 MECHANICAL SEALS

- A. Each pump shall be provided with a tandem mechanical shaft seal system consisting of two totally independent seal assemblies. The seals shall operate in a lubricant reservoir that hydrodynamically lubricates the lapped seal faces at a constant rate.
- B. The lower, primary seal unit, located between the pump and the lubricant chamber, shall contain one stationary and one positively driven rotating, corrosion resistant silicon or tungsten-carbide ring.
- C. The upper, secondary seal unit, located between the lubricant chamber and the motor housing, shall contain one stationary and one positively driven rotating, corrosion resistant silicon or tungsten-carbide seal ring.
- D. Each seal interface shall be held in contact by its own spring system. The seals shall require neither maintenance nor adjustment nor depend on direction of rotation for sealing. The position of both mechanical seals shall depend on the shaft. Mounting of the lower mechanical seal on the impeller hub will not be acceptable. The seals shall require neither maintenance nor adjustment and shall be readily accessible for inspection and replacement.
- E. Shaft seals lacking positively driven rotating members or conventional double mechanical seals which utilize a common single or double spring acting between the upper and lower units and requiring a pressure differential to offset external pressure and effect sealing, will not be acceptable. The seals shall not rely upon the pumped media for lubrication.

2.11 COOLING SYSTEM

- A. Each pump/motor unit indicated to require a cooling jacket shall be provided with a closed-loop cooling system. The cooling system shall provide for continuous

submerged or partially-submerged pump operation in liquid having a temperature of up to 104 degrees Fahrenheit (40 degrees Celsius), in accordance with NEMA standards. Restrictions limiting the liquid temperatures at levels less than 40 degrees C are not acceptable. The cooling system shall provide heat dissipation for the motor regardless of whether the motor unit is fully-submerged in the pumped media or submerged only to the top of the volute.

2.12 MOTORS

- A. The motor design shall be NEMA design B, squirrel cage induction. Explosion-proof rating shall be NEC 500, Class 1, Division 1, Group C & D, Class T3C maximum surface temperature.
- B. The motor stator, rotor and bearings shall be mounted in a sealed submersible housing. The motor filling medium shall be air or non-toxic oil. The stator windings shall have Class H insulation. Motors shall be equipped with thermal overload protection capable of tripping associated motor starter and then resetting automatically after cool down. Motors shall be equipped with moisture detection probe in a seal sensing chamber, filled with non-toxic oil, and provide motor leakage protection.
- C. Motors shall be sized so they are not loaded above full load rating at any point on the impeller operating curve. Operation in the motor "service factor" range is not acceptable.
- D. Minimum motor efficiency shall be per NEMA MG-1-12.54.1.
- E. Motors shall be as noted in Section 2.02, suitable for 460 VAC, 3 phase, 60 HZ operating power. Maximum power required by the pump in the operating head range shall not exceed 90 percent of the motor nameplate rating.
- F. shall be high efficiency, inverter-duty rated. Motor shall not exceed Class A temperature rise when operating in the installed condition.
- G. The pump and motor shall be designed so that they will operate in a fully-submerged or partially-submerged condition in the water. Each motor shall be capable of and rated for continuous operation duty under pump conditions, without exceeding Class A temperature rise limits for the motor insulation system.
- H. Motors shall be rated for a minimum of 10 starts per hour.
- I. The motor stator shall be held in place by a removable end ring that may be easily removed in the field without the use of heat or a press. The electrical power cord shall be terminated in a terminal box, which is sealed on the top and bottom to allow disconnection of the power leads without allowing moisture entry into the motor casing.

- J. A heat sensor thermostat shall be attached to motor winding and shall be connected to the motor starter to stop motor if motor winding temperature reaches 140°C. Thermostat to reset automatically when motor cools. Two heat sensors are to be used on three-phase motors.

2.13 POWER AND CONTROL CABLES

- A. The power and multi-conductor cable assemblies shall be routed in cable trays and/or conduits and shall extend from the pumps to the respective VFD locations on the operating floor of the pump station. A minimum of 10 feet (304.8 cm) of excess cable shall be provided for slack and coiled at the motor.
- B. The power cable(s) shall be submersible cable designed specifically for submersible pump applications and be sized according to NEC and ICEA standards for the length of cable required. The outer jacket of the cable shall be oil resistant chloroprene rubber. The motor and cable shall be capable of continuous submergence underwater without the loss of watertight integrity to a depth of 65 feet (1981.2 cm).
- C. The control cable shall be multi-conductor submersible cable designed specifically for submersible pump applications. The cable shall be multi-conductor type with stainless steel braided shielding, a chloroprene rubber outer jacket and tinned copper conductors insulated with ethylene-propylene rubber. The conductors shall be arranged in twisted pairs. The cable shall be rated for 600 V and 194 degrees Fahrenheit (90 degrees Celsius) with a 40 degree C ambient temperature and shall be approved by Factory Mutual (FM).
- D. The cable entry water seal shall include a strain relief and a grommet type seal designed so that a specific fastener torque is not required to ensure a watertight, submersible seal. The cable entry junction box and motor shall be separated by a stator lead sealing gland or a terminal board. The junction box shall isolate the motor interior from moisture gaining access through the top of the stator housing. The assembly shall provide ease of changing the cable when necessary using the same entry seal.

2.14 PROTECTION DEVICES

- A. Provide a complete pump monitoring system for each pump capable of monitoring all thermal switches, temperature sensors, leakage sensors and required for pump protection. The monitoring system shall include a base module. The base module shall be furnished with the pump and installed by the Contractor. Modules shall be Flygt "Mini-CAS" or equal. Modules shall be 120VAC/ 1 phase. If modules are not 120VAC, any required power transformers shall be provided by pump supplier.
- B. Motors shall be protected by one motor temperature switch embedded in each phase winding. Each switch shall be designed to operate at 140°C. Each switch

shall be normally closed automatic reset type rated 5 amps at 120 volts ac. The switches shall be wired in series with end leads wired to terminals within the motor housing. Should high temperature occur, the thermal switches shall open stopping the motor and activating an alarm.

- C. Motor housings shall be provided with a moisture detection system. Two leakage sensors shall be provided to detect water intrusion into the stator chamber and into the junction chamber. A float leakage sensor shall be used to detect the presence of water in either the stator chamber or junction chamber. When activated the float leakage sensors will stop the motor and activate an alarm.

2.15 GUIDE RAIL, CABLE HOLDERS, CHAINS, AND DISCHARGE BASE ELBOW

- A. The pump shall be mounted on a rugged heavy duty, non-sparking dual guide rail and self-connecting, pedestal-mounted discharge base elbow assembly system for pump installation and maintenance without confined space entry. The guide rail and base elbow assembly shall be non-sparking, approved for Factory Mutual use in NEC Class 1, Division 1, Group C & D environments and compatible with pumps of any manufacturer, having standard ANSI class 125 pump discharge flanges. The base shall be suitable for grouting and bolting to the Lift Station concrete base pad.
- B. The pump lifting chain shall be of a stainless steel lifting chain of sufficient length to lift and remove pump for ease of inspection and removal from pump operating position to 20 feet (609.6 cm) above finish surface grade elevation. The lifting hoop shall be stainless steel rated for a minimum of three times the weight of the pump with the volute containing water. The working load rating of the lifting system shall be a minimum of 50 percent greater than the weight of the pump with the volute full of water.
- C. Contractor shall coordinate concrete pad sizing for mounting of pedestal base with manufacturer based upon the mounting requirements and the required pump elevation settings.
- D. Contractor shall coordinate guide rail mounting brackets with manufacturer. Intermediate guide rail braces shall be stainless steel.
- E. Provide a stainless steel cable holder.
- F. Each pump shall have a centreline discharge equipped with and automatic pipe coupling arrangement for ease of installation and piping alignment. The pumps shall automatically connect to the discharge piping when lowered into position.

2.16 PEDESTAL-MOUNTED PAINTING

- A. Pumps shall be painted in accordance with manufacturer's recommendations for the materials proposed and be suitable for submerged or non-submerged

environments. The coating system shall have a minimum dry film thickness of 6 mils and shall consist of a prime (first) coat and one or more finish coats. At least 1 quart of the finish coat material shall be furnished with each pump for field touch-up.

2.17 ANCHOR BOLTS

- A. Contractor shall provide anchor bolts of ample size and strength required to securely anchor each item of equipment in accordance with manufacturer's requirements. Anchor bolts shall be long enough to accommodate a minimum of 1.5 inches (38.1 mm) of grout beneath the baseplate. Bolts, washers and nuts shall be AISI Type 304 stainless steel unless otherwise noted.
- B. Anchor bolts shall be set by the Contractor using templates provided by the equipment manufacturer. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.
- C. Anchor bolts shall be accurately located and centered between pipe sleeves having an inside diameter approximately 2.5 times the bolt diameter and a length approximately 8 times the bolt diameter. A square anchor plate with a thickness of approximately half the bolt diameter and side dimensions of 4 times the bolt diameter shall be welded to the bottom of each sleeve, with the anchor bolt extended through the plate and welded thereto. Two nuts and a washer shall be provided with each bolt.

2.18 SPARE PARTS

- A. Furnish lubricating materials to allow for one year of operation. Lubricating materials shall be as recommended by the manufacturer.
- B. One spare impeller.
- C. Two sets of mechanical seals.
- D. One wear plate.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations.
- B. Systems to be installed complete with all necessary floats, controls, connections, valves, pipes, and fittings.
- C. Contractor responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.

- D. Contractor shall complete all electrical power and control connections as specified.
- E. Permanently install discharge elbow on the discharge piping.
- F. Plumb and properly install and orient guide rails.
- G. Install intermediate guiderail supports if required by manufacturer or deemed necessary by Engineer.

3.02 FIELD QUALITY CONTROL

- A. Manufacturers Field Service
 - 1. Provide services of an Experienced, Competent and Authorized Representative of Manufacturer for a minimum of eight (8) hours:
 - a. Inspect equipment covered by these Specifications.
 - b. Supervise any adjustments and installation checks.
 - c. Conduct start-up of equipment and perform operation checks and tests.
 - d. Reference Sections 01 45 00 and 01 75 00 for additional requirements.
 - 2. Furnish Owner and Engineer with a written report prepared by equipment supplier certifying that equipment:
 - a. Has been properly installed.
 - b. Is in accurate alignment.
 - c. Is free from an undue stress imposed by connecting piping, anchor bolts, or operational water hammer.
 - d. Has been operated under full load conditions and that it operated satisfactorily.
- B. Functional Test. A pump test will be conducted on each of the pumps, individually. The test will be to verify proper operation of the pumping unit and will include operating the pump at different flows and pressures over the operating range. The final part of the test will be to operate the pump at design flow for a minimum of 15 minutes without a shutdown. The Manufacturer's Representative will be present and approve the complete testing operational procedure. Testing shall not be conducted until all pumping equipment, piping and valves, and supporting systems, including controls and related work, has been completed. The Contractor will be responsible for scheduling and providing all materials and equipment necessary to conduct the test. This will include providing and installing temporary facilities. The test will be conducted by pumping from the wetwell through the pump discharge piping and back to the wetwell.
- C. Performance Test. Performance test shall be conducted as part of Facility Startup and Performance Evaluation. Testing shall be under actual conditions.

Pumps shall be tested individually across the entire range of flow and pressure specified.

3.03 OPERATOR TRAINING

- A. Manufacturer shall provide four (4) hours of operator training by a qualified representative of the manufacturer for OWNER'S personnel after system is operational. Training will occur on a schedule convenient to the OWNER. Training will not take place while manufacturer's representative is at the job site during start up or demonstration testing.
- B. Contractor shall record training via digital video camera so Owner can use again in the future.

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DIVISION 46 WATER AND WASTEWATER EQUIPMENT

SECTION 46 05 01
WASTEWATER EQUIPMENT GENERAL PROVISIONS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes:

1. General provisions for wastewater equipment:
 - a. Motors
 - b. Gear Reducers
 - c. Guards
 - d. Shear Pins
 - e. Flexible Shaft Couplings
 - f. Enclosures
 - g. Anchor Bolts and Fasteners
 - h. Factory Surface Preparation and Painting

B. Related Sections Include:

1. Section 01 33 00 - Submittal Procedures
2. Section 01 45 00 - Quality Control
3. Section 01 61 00 - Common Product Requirements
4. Section 01 75 00 - Starting and Adjusting
5. Section 01 77 00 - Closeout Procedures
6. Section 01 78 23 - Operation and Maintenance Data
7. Division 26 – Electrical

1.02 REFERENCES

- A. The following references, in their latest revision, form part of this specification. To the extent specified, the requirements of this specification prevail in case of conflict.
- B. Hydraulic Institute
 1. Standards for Centrifugal, Rotary and Reciprocating Pumps – Test Code.
- C. American Society for Testing and Materials (ASTM)
- D. American Gear Manufacturers Association (AGMA)
- E. American Institute of Steel Construction (AISC)
- F. American Welding Society (AWS)
- G. Steel Structures Painting Council (SSPC)

- H. American Society of Civil Engineers (ASCE)
- I. NFPA 820: Comply with most current edition of National Fire Protection Association Standard for Fire Protection in Wastewater Treatment and Collection Facilities for electrical equipment installed within borders indicated on the Drawings.
- J. National Electric Code (NEC-501)

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit detailed specifications, drawings and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for each complete operational system.
- B. Operations and Maintenance Data: Submit on all parts, devices, equipment, and other accessories forming the complete operational system.
- C. Shop drawings for all items of mechanical and electrical equipment specified in Division 46, including accessory items, shall be submitted for approval.
- D. Shop drawings shall be specific to this project with inappropriate information clearly removed. Each shop drawing shall clearly indicate the specific piece of equipment being referenced. Each shop drawing shall clearly indicate the specific system being referenced.
- E. Preliminary characteristics performance curves for all process pumps shall be submitted with associated shop drawings. Performance curves shall include operating head, brake horsepower and efficiency, plotted against pump capacity, as a minimum.
- F. Certified performance curves for all specific process pumps shall be approved by Engineer prior to shipping pumps. Certified curves shall include specific pump serial numbers.
- G. Manufacturer's preliminary operation and maintenance manuals for specific pieces of equipment shall be submitted with shop drawings. Shop drawings will not be reviewed until preliminary operation and maintenance manuals are submitted for review.
- H. After equipment installation, and before acceptance of equipment, submit final instruction manual containing complete information with respect to assembly, operation, maintenance, repair, and adjustment of all equipment. Manuals shall be submitted to Engineer for transmittal to Owner.

1.04 PROJECT RECORD DRAWINGS

- A. Changes from original project drawings and specifications shall be compiled by CMAR and submitted to Engineer. Changes shall be clearly indicated through drawings and the written word.

1.05 QUALITY ASSURANCE

- A. The Contract Documents represent the minimum acceptable standards for the equipment in Division 46. Standard manufacturer products shall be redesigned and modified from standard mode, if necessary, or provided with special features, accessories, materials, or finishes as may be necessary to conform to the requirements of the specifications and the drawings.
- B. All furnished equipment and systems shall conform completely to the requirements of specific drawings and specifications.
- C. Steel design and fabrication shall conform to the standard practices of the American Institute of Steel Construction (AISC).
- D. Equipment and systems shall be suitable for mounting on level concrete surfaces with all live and dead loads transmitted within the limits of the concrete specified.
- E. Each piece of equipment furnished shall have a standard nameplate securely attached in an easily viewed location showing the name of the manufacturer and the serial number of the specific unit. The nameplate shall also provide the rated capacity of the unit at specified conditions. Motor nameplates shall show the horsepower, speed and electric current characteristics of each specific motor. The nameplate of distributors is not acceptable.
- F. Drawings and specifications are complimentary and what is called for in either one shall be binding as if called for in both.
- G. For locations indicated on plan drawings, CMAR shall follow the requirements called out in NFPA 820 regarding NEC-501.

1.06 QUALIFICATIONS

- A. Unless otherwise specified in individual specification sections, the following minimum requirements shall apply to all products specified in Division 46:
 - 1. No equipment shall be supplied by any manufacturer not regularly engaged in the manufacturing and production of equipment designed for use in wastewater treatment.
 - 2. The manufacturer must have installed and had in satisfactory use for a period of not less than five (5) years a minimum of five (5) installations having similar size and type of equipment as compared to the units specified.

3. Experience information shall be furnished with shop drawings. The term "installations" shall mean individual projects/contracts. Multiple equipment units for a project will be considered as one (1) installation toward meeting the experience requirements. Installations shall be only in the United States (fifty states). Information shall include, but not limited to, the following:
 - a. Name and location of installation.
 - b. Name of person in direct responsible charge for the equipment.
 - c. Address and phone number of person in direct responsible charge.
 - d. Month and year the equipment was placed in operation.
 - e. Brief description of equipment.

1.07 PROJECT CONDITIONS

- A. CMAR shall be responsible for verifying any dimensions of existing or proposed structures, piping, or equipment required for the proper fabrication and installation of all new equipment and the necessary connections.
- B. Discrepancies found before or after the work has started, shall be immediately brought to the attention of the Engineer. Engineer reserves the right to require minor changes in the work of the CMAR to eliminate such discrepancies.
- C. Prior to roughing in any facilities, or installing any equipment, CMAR shall consult all drawings (general, structural, process, mechanical, electrical, and etc.) and shall inform himself of structural members, ceilings, pipes, ducts, materials, finishes, and etc., which may affect the installation.
- D. CMAR shall examine all substrata, openings and conditions under which materials and equipment are to be installed. CMAR shall not proceed with work until unsatisfactory conditions are corrected.
- E. Drawings indicate the size and general arrangement of all equipment and piping. The final exact location and dimensions will be determined by the actual equipment furnished.
- F. CMAR shall determine and be responsible for the proper location and character of all sleeves, chases, inserts, hangers, anchor bolts, openings, and etc. in the construction for mechanical and process equipment and piping installation. CMAR shall be responsible to have anchorage items delivered to the project site in ample time to prevent a delay in associated work.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Box, crate, or otherwise completely enclose and protect all equipment during shipment, handling, and storage in accordance with Section 01 61 00 - Common Product Requirements.

- B. Protect equipment from exposure to elements and keep all items thoroughly dry at all times.
- C. Primed or Painted Surfaces: Protect against impact, abrasion, discoloration, and other damage. Factory finished coatings damaged during shipment, unloading, and original storage will be the responsibility of the Seller. Factory finished coatings damaged during long term storage, assembly, and installation will be the responsibility of the Installation Contractor. Responsible party will be expected to repair damaged coatings per manufacturer's recommendations at no additional cost to the Owner.
- D. Protect electrical equipment, controls, and insulation against moisture or water damage.
- E. Store pumps, motors, and electrical equipment in weather tight areas and maintain temperature of 50°F minimum.
- F. Rotating equipment in storage shall be rotated by hand weekly to protect the life of new bearings.

1.09 MAINTENANCE AND SERVICE

- A. If not indicated in individual specification sections, Manufacturer's authorized representative shall provide a minimum of four (4) hours for on site field calibration, startup, and training services for each specific piece of equipment.
- B. A factory serviceman and service vehicle equipped with tools to make all necessary repairs, as well as component parts required to maintain satisfactory operation of the equipment outlined in these Specifications, shall be available if needed, without undue delay.
- C. Manufacturer's authorized representative shall provide a start-up report, to be included in the submittal of the final Operations and Maintenance Manuals, documenting site visit, start-up, and installation and/or operational recommendations made during start-up.

1.10 REGULATORY REQUIREMENTS

- A. All Products that may come into contact with water intended for use in a Public Water System shall meet American National Standards Institute (ANSI)/National Sanitation Foundation (NSF) International Standards 60 and 61, as appropriate. A Product will be considered as meeting these standards if so certified by NSF, the Underwriters Laboratories, or other organization accredited by ANSI to test and certify each Product.

1.11 WARRANTY

- A. Unless otherwise noted a written manufacturer's warranty shall be provided for the equipment specified. The warranty shall be for a minimum period of one (1) year from Final Acceptance. Such warranty shall cover all defects or failures of materials or workmanship that occur as the result of normal operation and service. Special warranty (guarantee) on individual pieces of equipment may also be called out in individual specification sections and shall take precedence.
- B. Guarantee all equipment against:
 - 1. Faulty or inadequate design.
 - 2. Defective construction or materials.
 - 3. Improper assembly.
 - 4. Leakage, breakage, or other failure.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All materials shall be new, undamaged and conform to the latest standards listed.

2.02 MOTORS

- A. Motors are specified in Division 26.
- B. Motors shall be selected to meet Seller's process treatment requirements, as supported by process design calculations.

2.03 GEAR REDUCERS

- A. Unless specified otherwise, all gear reducers shall be horizontal straight-line concentric type with heat treated alloy steel precision cut helical gearing. AGMA rating plates shall be attached to the gear housing. All gearing shall comply with the requirements of the AGMA. All gearing will be provided with a 1.5 service factor for continuous operation.
- B. Unless specified otherwise, all shafts shall be of high carbon steel forgings turned and grounded to size. All gearing shall be lubricated by revolving through an oil reservoir. Lubrication shall be adequate to provide both lubrication and cooling. Shafts shall be mounted on anti-friction bearings. All shafts shall be provided with oil seals. Housings shall protect against dust and moisture intrusion. Housings shall be provided with an easy means of filling, draining, and checking oil levels.
- C. Unless specified otherwise, drive motors shall be separate from the gear reducer. Motor shaft shall be connected to the gear reducer with a shear pin or torque overload coupling to protect against overload.

2.04 GUARDS

- A. All rotating shafts, couplings, and belts shall be covered by an OSHA approved, and substantial, removable sheet metal or expanded metal guard or screen.

2.05 SHEAR PINS

- A. Unless specified otherwise, shear pins shall be fabricated of 2017T4 aluminum, cold-headed rod, conforming to the standards set forth in ASTM B316-90.
- B. Furnish pins that are 0.0002 inch oversized, and of constant diameter. Pins shall not be necked down in any way. Hubs or bushings shall be furnished to ensure that larger pins cannot be installed.
- C. Pins shall have a Brinell hardness of at least 300 when tested with a 500 kg load and 10mm ball.
- D. One end of the pin shall be chamfered and the other end provided with a radius to form a crown.

2.06 FLEXIBLE SHAFT COUPLINGS

- A. Unless specified otherwise, flexible shaft couplings for connection of motor and equipment drive shafts shall be of the non-metallic flexible member type. Flexible element shall be of reinforced rubber tire type held in place by twin flanges. No lubrication shall be required. Coupling shall eliminate metal to metal contact between driver and driven shafts in the coupling. Coupling shall act to cushion shock loads.
- B. Coupling design shall allow for replacement of flexible element without moving either driver or driven equipment.
- C. Couplings shall accommodate angular misalignment up to 4 degrees, parallel misalignment of up to 1/8 inch, and end float of up to 5/16 of an inch, either singularly or in any combination.

2.07 ENCLOSURES

- A. Unless specified otherwise, control devices appurtenant to major equipment shall be provided with dust and moisture tight enclosures.
- B. Unless specified otherwise, electrical conduit connections shall be of the threaded type.

2.08 ANCHOR BOLTS AND FASTENERS

- A. Equipment manufacturer shall furnish all anchor bolts of proper size and strength to securely anchor each piece of equipment. Anchor bolts and fasteners shall be set by template and protected from misalignment by CMAR. Equipment shall be leveled, shimmed, bolted down, and grouted in place with a non-shrinking type

grout. Unless specified otherwise on the drawings or in individual specification sections, anchor bolts, and fasteners shall be 304 stainless steel. Anchor bolts shall be of the embedded, headed, type. Expansion type, and adhesive type, anchors will not be acceptable.

2.09 FACTORY SURFACE PREPARATION AND PAINTING

- A. Thoroughly clean, fill and smooth surfaces, as necessary, to provide a smooth and uniform base for applying coatings.
- B. Permanently protect surfaces which will not be accessible after assembly or installation of equipment.
- C. Protect all steel and iron surfaces by applying proper factory coatings and finishes.
- D. Provide a protective coating to surfaces that are to be painted after installation. Protective coatings are to be compatible with coating systems specified in Section 09 90 02 - High Performance Painting and Coating.
- E. Provide an oil resistant factory finish on electric motors, speed reducers, starters, and other self contained or enclosed components which is compatible with the coating systems specified in Division 09.
- F. Apply a rust prohibiting compound on all machined, polished, and ferrous surfaces which are not to be painted.

PART 3 - EXECUTION

3.01 FACTORY TESTS

- A. All process equipment will be subjected to factory testing as specified in individual specification sections, and in accordance with the overall testing requirements specified in Division 01.
- B. Process equipment which does not pass testing requirements shall be replaced with equipment which does meet the specified requirements.
- C. Factory testing of all pumping equipment shall be in accordance with Hydraulic Institute Standards.
- D. Certified factory performance test curves for each pump shall be furnished to Engineer, and approved by Engineer, before shipment of the pump to the construction site. Certified test curves shall cover the full operating range, from shut off, to maximum capacity.

3.02 INSPECTION

- A. CMAR shall inspect all equipment as it is delivered to ascertain if the equipment has arrived at the project site in a damaged condition, and to determine if any parts are missing.
- B. CMAR is responsible to repair or replace damaged items in accordance with manufacturer's instructions, and Engineer's approval.

3.03 FIELD PREPARATION AND PAINTING

- A. Immediately following receipt of equipment at the construction site, CMAR shall touch up paint damaged in shipping with paint supplied by the equipment manufacturer. Touch up paint shall be compatible with coating systems specified in Division 09.
- B. Unless specified otherwise, finish field preparation and painting shall be in accordance with specification Division 09.
- C. Prior to assembly, all stainless steel bolts, nuts, and fastener threads shall be coated with a non-seizing compound.

3.04 INSTALLATION

- A. Furnish and install all equipment as shown on the drawings in accordance with manufacturer's recommendations, to provide for a complete and operational system.
- B. CMAR shall make appropriate allowances in their guaranteed maximum price (GMP) for the fact that the Owner must continue to operate the wastewater treatment facility to meet NPDES effluent standards. CMAR's activities at the site must be coordinated to meet this requirement.
- C. Connections to existing plant piping and processes, modifications to existing plant piping and processes, and relocation of existing piping and processes required for proper installation of new equipment shall be performed on a continual basis, and coordinated with Owner and Engineer, to minimize shut down time of wastewater treatment facilities.
- D. Coordinate with other trades to minimize interferences in the installation of work, and to minimize delays.
- E. CMAR shall provide all necessary scaffolding for installation of this work in conformance with the standards of any local, state, and federal codes applying to scaffolding.
- F. Oil and grease required for initial operations, and acceptable to the equipment manufacturer, shall be provided by the CMAR.

3.05 FIELD TESTING

- A. Field testing shall be performed in accordance with individual specification sections, and in accordance with the requirements of Division 01.
- B. Excessive equipment vibration shall be cause for rejection of the equipment.
- C. Motors shall be field checked for compliance with current limitations indicated in Division 26.

3.06 START-UP AND ADJUSTMENT

- A. The equipment manufacturer shall inspect the completed installation and make all necessary adjustments and corrections prior to equipment start-up.
 - 1. Check equipment clearances.
 - 2. Remove debris from in and around equipment.
 - 3. Check for proper lubrication.
 - 4. Check for ease of rotation of rotating equipment. Check direction of rotation.
 - 5. Check for proper valve positions.
 - 6. Check for alignment of all parts.
 - 7. Check that all nuts and fasteners are adequately torqued.
- B. Following start-up authorization by Engineer, the equipment manufacturer shall supervise the actual starting of the equipment. The equipment manufacturer shall make all final adjustments of the operating equipment, and shall provide written certification that the equipment is properly installed, adjusted, and operating properly.
 - 1. Check safety equipment.
 - 2. Check lubrication systems, and lubricant usage.
 - 3. Check temperatures of bearings and seals.
 - 4. Check motor loads.
 - 5. Check that the system is operating under all design conditions.
 - 6. Check for excessive vibration.
 - 7. Check for excessive noise.
 - 8. Optimize system operation.
 - 9. Provide initial operation instruction to Owner.
- C. See Section 01 75 00 - Starting and Adjusting for additional requirements.

3.07 WRITTEN REPORT (CERTIFICATION)

- A. CMAR shall provide manufacturer's written certification to Engineer for approval, and transmittal to Owner. Manufacturer shall certify that the equipment:
 - 1. Is properly installed.
 - 2. Is properly lubricated.

3. Is properly and accurately aligned.
 4. Has been operated at all design load conditions, and is operating satisfactorily.
 5. Is free from stress caused by connecting pipes and other attachments.
- B. Final acceptance of equipment will not be provided until written certification is provided and approved by Engineer.

3.08 OPERATOR TRAINING

- A. The manufacturer shall provide the minimum hours of operator training on the proper use and maintenance of the equipment, as specified in individual specification sections.
- B. Time of operator training shall be coordinated and agreeable to Owner and Engineer.
- C. Operator training hours may not be consecutive.
- D. Operator training will usually take place after start-up.

3.09 SPARE PARTS

- A. All spare parts shall be new and identical to the original equipment. Spare parts shall be packaged in individual boxes suitable for long term storage. Spare parts required shall be as listed in the individual specifications sections.
- B. CMAR shall provide the Owner with all spare parts called for in individual specification sections. Spare parts shall be provided to the Owner at the wastewater treatment plant site.

END OF SECTION 46 05 01

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SECTION 46 21 35
CYLINDRICAL PERFORATED PLATE SCREENS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes all labor, materials, equipment, and incidentals required to provide:

1. One (1) semi-cylindrical perforated plate screen for removing floating, particulate and fibrous material and for conveying, washing, dewatering and compacting the screenings before discharging the material into garbage can; as shown on the Drawings and described in the following specification.
2. The perforated plate screen shall be located in the Pretreatment Building (PTB) in the main channel.
3. The screen shall consist of a perforated plate screen basket, concentric screw conveyor/dewatering screw, screenings press with drive unit, support structure, pivot stand, spray wash system, main control panel, local control station, ultrasonic level transducers, and electrical control system.

B. Related Sections include:

1. Division 01 – General Requirements
2. Division 26 – Electrical
3. Division 40 – Process Interconnections
4. Section 46 05 01 - Wastewater Equipment General Provisions

1.02 REFERENCES

A. Applicable Standards

1. American Friction Bearing Manufacturers Association (AFBMA).
 - a. Standard 9-90 Load Ratings and Fatigue Life for Ball Bearings.
 - b. Standard 11-90 Load Ratings and Fatigue Life for Roller Bearings.
2. American Gear Manufacturers Association (AGMA).
3. American Iron and Steel Institute (AISI).
4. American Institute of Steel Construction (AISC).
5. American National Standards Institute (ANSI).
6. American Society for Testing and Materials (ASTM):
 - a. Section A322: Carbon and Alloy Steel Bar Specifications.
 - b. Section A507-10: Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot- Rolled and Cold Rolled
7. American Welding Society (AWS).
8. National Electrical Code (NEC).

9. National Electrical Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA).
11. Occupational Safety and Health Act (OSHA).
12. Underwriter's Laboratories (UL).
13. American Structures Painting Council (ASPC).
14. ISO 9001
15. ISO 14001

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00. In general, include detailed data covering specifications, drawings, materials, parts, motors, sizes, capacities, dimensions, weights, lifting points, parts list, spare parts, clearance distances, wiring diagrams, controls, and other accessories forming part of equipment for the complete operational system.
- B. Product Data: Include the following:
 1. Descriptive literature, brochures, catalogs, cut-sheets and other detailed descriptive material of the equipment.
 2. Motor characteristics and performance information.
 3. Gear reducer data including service factor, efficiency, torque rating, and materials.
 4. Parts list including a list of recommended spare parts.
- C. Shop Drawings: Include the following:
 1. Manufacturer's installation drawings.
 2. Wiring and schematic diagrams.
- D. Operations and maintenance manual.
- E. Detailed installation instructions, with clear step-by-step points on the correct mechanical and electrical installation procedures.
- F. Equipment weights and lifting points.
- G. Recommendations for short- and long-term storage.
- H. A copy of the manufacturer's warranty.
- I. A copy of documents proving certification of the Manufacturer's Quality Management System according to ISO 9001 and Environmental Protection Management System according to ISO 14001.
- J. Failure to include all drawings applicable to the equipment specified in this section will result in rejection of the entire submittal with no further review.

- K. Furnish Manufacturer's field service reports under provisions of Section 01 33 00, reports covering start up, adjusting, commissioning, demonstration, and training.
- L. Submit operation and maintenance manuals and Manufacturer's instructions in accordance with Sections 01 33 00 and 01 78 23.
- M. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.04 DESCRIPTION OF WORK

- A. Provide:
 - 1. One (1) perforated plate screen with integral washer/dewatering/compactor unit.
- B. Screen shall be provided with the following:
 - 1. Screen, wash press, motors, gear reducers, controls, control panels, and lifting attachments.
 - 2. All items necessary for complete assembly.
 - 3. All appurtenances and safety devices required for proper operation.
 - 4. All manuals, drawings, parts list, and special tools required for assembly, maintenance, and operation.
 - 5. Lubricants (if required) for start-up procedure specified.
 - 6. Standard set of spare parts
- C. The screen shall be used to screen raw domestic wastewater in concrete channels which flow by gravity to the Pretreatment Building (PTB).
- D. The Screen System Supplier shall furnish and commission the Screen system as described in this specification and other associated documents, inclusive of all equipment, instrumentation, scope-specific piping systems, controls, integration, training, startup, commissioning and warranty support.
- E. The washed and dewatered screenings shall be discharged to a dewatered screening dumpster complete with drain and hinged covers and supplied by Owner.
- F. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the Screen System in accordance with the installation instructions provided by the Supplier. Once installed, the Screen System shall be complete and operational with all control equipment and accessories as specified herein or as otherwise required for a fully functional and operational system. The

Screen Supplier must clearly identify in detail all exceptions to the Services and Scope of Supply described in this Specification and include such list with their proposal package

1.05 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of ten (10) years' experience producing equipment substantially similar to that required and shall be able to submit documentation of at least ten (10) independent installations in the United States using the same size or larger equipment as detailed in the below, and in municipal wastewater applications. Each installation must have been in satisfactory operation for at least five (5) years. For the purpose of experience, Manufacturer requirements shall extend to include the named manufacturer/supplier on equipment in addition to physical Manufacturer.
- B. Manufacturer shall provide screen, integral wash press, motors, gear reducers, controls, control panels, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system. The manufacturer shall test-run the fully assembled machine in the factory before shipment.
- C. In order to assure uniform quality, ease of maintenance, minimal parts storage, compatibility, integrity of the individual components, and provide the specified warranty for all components, it is the intent of these specifications that all equipment and components called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- D. The Contract Documents represent the minimum acceptable standards for the equipment for this project. Equipment shall conform fully in every respect to the requirements of the respective parts and sections of the Drawings and specifications. Manufacturers shall modify, redesign, and furnish with special features or accessories, use materials or provide equipment with finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of this specification.
- E. Drawing layouts, item weights and specification language for the screen assemblies is based on Huber Technology, Huntersville, NC. Screen equipment shall be provided by Huber Technology or approved equal.
- F. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected

designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the Manufacturer and not the Owner.

- G. Manufacturer shall have a screen tested with panels of same size perforations and range of flows per plate surface area. Testing and report shall be conducted by an authority independent of the manufacturer. Test results shall include headloss and solids screen capture quantities and ratio with total solids contained in wastewater.
- H. The entire unit shall be manufactured from AISI 304L stainless steel shapes. All components made of stainless steel shall be passivated by full submergence in a pickling bath for perfect surface finishing.

1.06 DELIVERY STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Owner until required for installation. Materials shall be transported, delivered stored and handled in accordance with manufacturer's instructions.
- B. Shipping to Point of Destination: The Supplier shall include the cost of factory testing, freight charges, transit insurance, and taxes. Shipping of the equipment shall be F.O.B., full freight to jobsite.
- C. Final delivery schedule shall be coordinated with Contractor.

1.07 WARRANTY

- A. The equipment Manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of twelve (12) months under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty. Multiple warranties for individual components shall not be acceptable.
- B. Warranty period shall begin after completion of performance and operation testing or after written acceptance of the installation by ENGINEER, whichever occurs earlier.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Huber Technology, Inc.
- B. Parkson Corporation
- C. Approved Equal.

- D. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section.

2.02 PERFORMANCE REQUIREMENTS

A. Screen Design Summary

1. Number of screens 1
2. Nominal screen basket diameter: 16"
3. Average flow per screen, MGD: 0.5
4. Max. Waste water flow per screen, MGD: 1.2
5. Max. Upstream water level, inches: Recommended by Supplier
6. Max. Wet screenings capacity, foot³/hr: Recommended by Supplier
7. Channel width, inch: 30", grout to Supplier recommendations
8. Channel depth, inch: 39"
9. Discharge height from top of channel, inch: Recommended by Supplier
10. Pre-treatment design: 1/4" fine screen
11. Max. TSS Concentration, mg/L: 250 mg/L
12. Screen opening size, inches: 0.24 inch (6 mm)
13. Location rating: Class 1, Division 1
14. Inclination Angle: 35 degrees

- B. The fine screens shall be designed to handle the maximum flow with the maximum upstream and downstream liquid levels as recommended by the Equipment Supplier.

- C. The average perforation flow through velocity shall not exceed 3.3 ft/sec under any flow condition up to the maximum clean water flow specified above. The screen design shall minimize solids deposits in the channel.

- D. The screens shall be capable of processing spherical objects with a diameter of 3-1/8". Such objects shall be conveyed through the auger and shall be discharged with the screenings. The unit shall be capable of processing the screenings load specified above.

- E. The fine screen shall have a semi-cylindrical screen basket made of perforated plate, and an integral screw conveyor and screenings press. The screw in the basket shall be provided with a brush on its flight for screen cleaning. The screen shall use a single drive for screening, conveying, dewatering and compressing the screened material.

- F. Operation of the screen shall be automatically initiated at a preset high upstream liquid level. A screen which operates continuously or via timer only will not be acceptable. The screw and integral brush shall remove solids from the flow and surface. The screenings shall be transported up the screw conveyor, through an

integrated screening washing system, a compaction and dewatering zone and then shall be discharged into transfer chute.

- G. The solids captured on the screen will gradually blind the submerged media causing the upstream water level to rise. At a predetermined water level of the screen programmed into the PLC; the conveyance spiral drive will operate. Design motors shall be activated to:
 - 1. Clean the drum screen.
 - 2. Transport, wash, compact, and convey the screenings to the transfer chute.
- H. Processed screenings shall be conveyed and deposited into the transfer chute (supplied by Manufacturer and specified herein) and to the dumpster (Owner to supply).
- I. The nominal opening, specified above, shall be the width of the circular perforated plate opening. Screen designs which define the bar spacing as the distance between a fixed bar element and a moving adjacent bar element are not acceptable. Screens using rotating rakes, wedge wire, or traveling filter media are also not acceptable.
- J. The design of the screen shall be such that there are no metal to metal wearing surfaces in the screening, transport, and compaction/dewatering sections of the screen to minimize maintenance labor and replacement parts costs.
- K. All open spaces of the screen shall be positively cleaned via a spray bar and cleaning brush system.
- L. The screening equipment shall produce dewatered screenings capable of passing the EPA Paint Filter Test as described in method 9095 of EPA Publication SW-486.
- M. To minimize odors and nuisance, the conveyance, dewatering and compaction zones shall be completely enclosed.
- N. The spray wash system shall be enclosed so that spray water, aerosols or leakage do not contaminate the operating floor.
- O. The control system shall be designed so that the cleaning characteristics of the screen and wash system can be changed via the programmable controller. Systems which do not offer this feature shall not be acceptable for this project.

2.03 MATERIALS

- A. Unless otherwise specified, the entire equipment shall be manufactured from AISI 304L stainless steel shapes including the screen basket, screw conveyor, outer screw conveyor housing, and support structure. All mechanical parts shall

be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the operation and maintenance manual. All parts being partially submerged, sprayed, or in contact with screenings shall be manufactured from AISI 304L stainless steel.

- B. The entire equipment shall be manufactured in a stainless steel only factory to prevent contamination of the stainless steel with foreign contaminants.
- C. The screening equipment shall be delivered completely assembled or in convenient sections as permitted by common carrier and required for installation.
- D. All equipment shall be designed and built for 24-hour intermittent or continuous service and for moderate shock without overheating, excessive vibration or strain.
- E. All stainless steel parts of the unit shall be fully submerged into a pickling bath for at least 8 hours to remove welding spots and to protect the stainless steel against corrosion. Glass bead blast or chemically treated stainless steel shall not be allowed.
- F. Fabrication shall be done in compliance with all applicable ASTM standards or equivalent international standards.
- G. All welding in the factory shall use shielded arc, inert gas, MIG or TIG method. Filler wire shall be added to all welds to provide for a cross section equal to or greater than the parent metal. Butt welds shall fully penetrate to the interior surface and gas shielding to interior and exterior of the joint shall be provided.
- H. All bolts, nuts and washers shall be 304L stainless steel.

2.04 SEMI-CYLINDRICAL SCREEN

- A. Screen
 - 1. The semi-cylindrical fine screen shall be designed and built to withstand all static and hydraulic forces exerted by the liquid to the screen. All structural and functional parts shall be sized for the loads encountered during screening, conveying and pressing operations.
 - 2. The perforated screen basket shall have a semi-cylindrical shape, which shall be open at the front and top. It shall be installed parallel to the wastewater flow direction. The screen basket shall be provided with a bottom plate lying flat on the channel floor. The screen shall be provided with an upper support flange and a conical transition piece between the screen basket and auger tube.
 - 3. Length and diameter of the screen basket and the thicknesses of the screen basket's upper support flanges shall be as specified above. The

flange shall be machined after welding to ensure proper alignment of the screen basket and auger.

4. The screen shall be provided with a pivoting support stand allowing for easy removal of the screen basket from the channel for maintenance purposes. The support stand shall be fabricated from stainless steel Double-C-Channels having minimum dimensions of 0.12"(3 mm). Seals between the screen and the channel wall shall be made of EPDM.

B. Screenings Conveyor and Screenings Wash-Press

1. The screen shall be cleaned with a shafted stainless steel screw with straight-shaped helical flights in the basket area designed to transport screenings. The straight helical flight design shall promote the creation of a self renewing layer of screenings to reduce brush wear.
2. The flights of the screw in the basket shall be provided with a ¼ inch thick hardened stainless steel strip having the same thickness as the flights of the screw. The strip shall be welded to the face of the flight, on both sides, over the full length of the screen basket. The flights of the screw shall be machined to match the screen basket such that the face of the strip is parallel to the screen basket's inner surface.
3. A stainless steel backed nylon brush shall be attached to the trailing edge of the screw flight over the entire length of the screen basket designed to reduce brush wear. This trailing edge brush design shall promote proper cleaning of basket perforations and shall prevent brush bristles from wedging between the screw and basket. The brush shall be attached by means of holding clips and fasteners made of stainless steel. Designs that place the brush on the leading edge of the flight will not be acceptable.
4. The screenings screw conveyor's tube diameter shall be 10.75" (273 mm) and shall have a wall thickness of 0.1" (2.6 mm). Two (2) anti rotation bars shall be welded to the inside of the transport tube along its longitudinal axis for continuous and controlled screenings transport. The screenings screw conveyor shall not be in contact with the anti rotation bars during normal operation. Screens which utilize wear bars that require replacement as part of a normal maintenance program shall not be acceptable.
5. A flange shall be welded to the conical transition piece to support and allow for removal of the screen basket. A gear box support flange shall be welded to the upper end of the auger tube for support and removal of the drive assembly. The flange thickness shall be a minimum of 0.31" (8 mm).
6. A shafted stainless steel screw with helical flight shall be installed in the auger tube for consistent conveying and proper compaction of the screened material. A shafted screw design shall have a rigid structure to prevent screw flexing and shall distribute the drive load uniformly. The shaft shall have a minimum diameter of 3 ½" (89 mm) and shall have

flights with a thickness of ¼" in the auger tube and a minimum thickness of 0.4" (10 mm) in the press zone. A shaft-less screw in the auger tube shall not be acceptable.

7. A replaceable auger wear strip shall be installed on the flight edge for screw and brush wear protection.
8. The upper end of the screw conveyor shaft shall be fitted with a solid stub having a diameter of 1.77" (45 mm). The stub and the screw conveyor shaft shall be accurately machined and shrink-fitted with each other. The entire screw shall be balanced and machined to ensure perfect alignment, screw conveyors with bolted on stub shafts shall be unacceptable due to lack of improper alignment.
9. After all flanges are welded to the auger tube, the faces of the flanges shall be machined on a lathe such that they are exactly rectangular to the tube axis.
10. A compaction zone shall be provided as an integral part of the screw conveyor and tube. The compaction zone shall be designed to form a plug of screenings material and to return water released from the screened material back to the channel through 13/64" (5 mm) diameter perforations that are machined into the screenings transport tube in a square configuration.
11. The compaction zone shall be provided with split glass fiber reinforced housing, furnished with gaskets and bolts, and shall be easily removable for 360° access to the compaction zone. Designs requiring removal of the drive assembly, discharge head, or screw conveyor to gain access to the compaction zone will not be acceptable. The housing shall be provided with a drain connection at its lowest point and a clamped flexible PVC hose for drain water whose other end directed directly back into the influent channel. The plastic housing shall also be provided with a 1" flush connection to allow periodic cleaning of the compaction zone.

C. Screen and Screenings Wash System

1. The screen and screenings wash systems shall be designed for a water supply of 16gpm at a pressure of 60 psi.
2. An automatic screen wash systems (IRGA) shall be provided. The screenings wash zone of the conveyor tube shall be provided with a minimum of three nozzles at its circumference. A spray bar shall be provided above the screw in the screen basket. The compaction zone housing shall be provided with a ring flush system to ensure complete flushing of the compaction zone housing. All water access points shall be provided with solenoid valves, piping and flexible reinforced PVC hoses.
3. The common water connection shall be provided with a brass body Y strainer. The strainer shall include a removable and washable stainless steel 20-mesh (800 micron) filter element. A water manifold with one input

and three output water connections shall be provided. The water input connection shall have a diameter of 1 ¼”.

4. The wash systems shall be operated on an intermittent basis only. Wash systems which operate continuously will not be acceptable.
5. The solenoid valves shall be operated by the programmable logical controller. Individual manual operation of each solenoid shall also be possible from the control panel.
6. Solenoid valves shall be stainless steel body, 2 way, and designed for 120 VAC operation with an explosion proof rating. Solenoid valves shall be normally closed and rated for up to 100 psig.
7. A water strainer shall be provided suitable for a 1-inch connection and a maximum flow rate of 25 gal/min and suitable for a maximum pressure of 150 psig . Water filter shall be a stacked filter element design with washable 80-mesh (200 micron) polyethylene or polypropylene disc elements, polypropylene head and bowl and Buna N gaskets. Stainless steel basket strainers with 80 mesh 304 stainless steel screens and plugged blow-off outlet shall also be acceptable.

D. Gear Motor Drive

1. The screw shall be driven by a shaft mounted geared motor. The geared motor shall have a minimum service factor of 1.0 equivalent to an AGMA Class I rating.
2. The gear reducer shall be bolted to a machined flange welded to the upper end of the auger tube.
3. The gear reducer shall be driven by a 3-phase, 60 Hertz, 230/460 volt, Class I, Division 1, continuous-duty motor with leads to a conduit box for outdoor operation. The motor power shall be a minimum of 1.5HP

2.05 CONTROLS SYSTEM

- A. All controls necessary for the fully automatic operation of the screen shall be provided, including a NEMA 12 main control panel, and a NEMA 7 local control station.
- B. Main control panel shall be suitable for indoor, wall-mounting. Enclosure shall be NEMA 12 Stainless Steel with continuous hinge and lockable door latch. The following shall be included and meet the requirements found within the Process Control Panels and Hardware specification section 40 63 13:
 1. Door-interlocked and non-fused disconnect
 2. Interior Light
 3. Starter for screen motor
 4. Control power transformer with properly sized miniature circuit breaker on primary side.
 5. 120 VAC transient voltage surge suppressor (TVSS)

6. CompactLogix PLC and I/O cards for control and monitoring of the system. Refer to Section 40 63 43 for PLC requirements.
 7. 7" Operator Interface Terminal (OIT) as specified in Section 40 53 13.
 8. Uninterruptible Power Supply (UPS) as specified in Section 40 53 13.
 9. Pilot lights for
 - a. Control power on (white)
 - b. Screen running (green)
 - c. Screen high level (amber)
 - d. Screen fault (red)
 10. E-stop push button (red)
 11. Screen reset push button (black)
 12. Door mounted elapsed time meters for the following:
 - a. Screen drive
 13. Flashing alarm light and alarm horn with silencer-reset button
 14. Plastic Nameplates
- C. The control panel(s) shall communicate with the Plant SCADA System utilizing the Ethernet/IP protocol over the Ethernet network.
1. All controls, indicators, inputs/outputs, setpoints, timers, alarms, etc., shall be available for communication with the SCADA System for integration into the HMI and facility's control system.
- D. A local operator station shall be provided and shall be suitable for wall-mounting. Enclosure shall be NEMA 7 cast Aluminum, and shall include the following:
1. Hand-Off-Auto selector switches for the following
 - a. Screen drive
 2. Screen forward-off-reverse
 - a. Screen drive
 3. Spray wash pushbuttons (push-to-test)
 - a. Spray bar
 - b. Screenings washing system (IRGA)
 - c. Compaction zone flushing
 4. E-stop pushbutton (red)
- E. The electrical control system shall provide for automatic control of the screen via the liquid level using a radar level sensing device as noted below in connection with an adjustable time clock. The screen shall operate at a high liquid level and or a pre-determined time sequence to provide a variable time between cleaning operations.
- F. A radar level sensing device shall be provided for level sensing and control as required. Provide as specified in the Level Measurement Section 40 72 00. Ensure device rating is suitable for the space it is being installed within.

1. A horizontal support shall be provided for mounting an ultrasonic sensor upstream from the system support frame. Support shall be 316 stainless steel.
- G. A high-level float switch shall be provided by screen manufacturer. Provide as specified in the Level Measurement Section 40 72 00. Ensure device rating is suitable for the space it is being installed within.
 1. Provide 316 stainless steel pipe and stainless steel clamp to mount float switch within screen channel. Coordinate final mounting depth during construction.
- H. The RESET pushbutton shall allow the control logic to be reset after the E-STOP pushbutton is pulled out. Additional pushbuttons and/or switches allowing for running the screen through a complete cleaning cycle shall also be provided. Designs incorporating the cleaning cycle into the RESET button may be acceptable with Engineer approval.

2.06 SEQUENCE OF OPERATIONS

- A. Hand Operation
 1. The spiral motor and spray wash shall run continuously.
- B. Automatic Operation
 1. The level sensor shall start the unit. After the liquid level has been lowered, the unit shall continue to run for the length of time set on the off delay timer, typically set at 30 seconds. The press zone spray wash shall typically operate whenever the spiral runs. A repeat cycle timer (on time first) shall be included to regulate the spray wash run time, as required.
 2. When a jam condition occurs in the auger Automatic or Hand modes, the auger shall be stopped and reversed to clear the obstruction. If the jam clears, the auger shall return to normal operation. One (1) additional auger reversal (2 times total) may occur within 30 seconds before the auger motor shall be de-energized and activate a fail relay and indicator.
- C. Emergency Stop
 1. The unit can be deactivated at any time by pressing either the control panel mounted or locally mounted Emergency Stop push button.
- D. Fault Conditions
 1. Motor overload or high current shall stop the drive motor and illuminate the fault light.

2.07 ACCESSORIES

- A. Provide all templates and special wrenches or tools necessary for proper installation and maintenance of Equipment.

2.08 ANCHOR BOLTS

- A. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be 316 stainless steel. Anchor bolts shall be wedge or epoxy type.
- B. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.09 SHOP SURFACE PREPARATION AND PAINTING

- A. Electric motors, speed reducers, and other self-contained or enclosed components shall have manufacturer's standard enamel finish.
- B. Clean all stainless steel surfaces and provide glass bead blast or chemically treat all external non wetted stainless steel to a uniform finish with Citrisurf 77. Chemical passivated stainless steel products shall not produce any hazardous wastes during the passivation process. The semi-cylindrical screen manufacturer shall clearly identify the passivation procedure methodology and shall certify that no hazardous wastes were produced.

2.10 SOURCE QUALITY CONTROL

- A. All structural stainless steel components shall be fabricated in the United States and shall conform to the requirements of "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" published by the American Institute of Steel Construction.
- B. All parts and assemblies shall be fabricated from sheets and plates of AISI Type 316 stainless steel with a finish conforming to AISI 316 and ASTM A666, unless noted otherwise. All rolled or extruded shapes shall be fabricated to conform to ASTM A276. All tubular products and fittings shall be fabricated to conform to ASTM A269, A351 and A403.
- C. All welding in the factory shall use shielded arc, inert gas, MIG, or TIG method. Add filler wire to all welds to provide for a cross section equal to or greater than the parent metal does. All butt welds shall be full penetration type to the interior surface. Provide gas shielding to interior and exterior of the joint.
- D. Welding of the screen components shall be in accordance with the latest edition of the American Welding Society (AWS) standards. Field welding of stainless steel will not be permitted.

- E. Bolts, nuts and washers shall be AISI 316 stainless steel furnished in accordance with ASTM A193.
- F. All surfaces that are specified to be machined shall be designed and fabricated to provide a runout of not more than 0.005 inches (0.13 mm) and a concentricity to within 0.005 inches.
- G. Design and fabrication of structural steel members shall be in accordance with AISC and AWS Standards. The manufacturer shall comply with the American Welding Society (AWS) and the American Institute of Steel Construction (AISC) most current listed standards and qualifications in 2004 D1.1, the criteria per the requirements of Section 6 - Inspection - Structural Welding Code. Evidence of such AWS and AISC compliance shall be submitted with shop drawing submittals as follows:
 - 1. The fabrication facility shall successfully meet the quality certification requirements of the AISC Quality Certification Program with a Category I or higher. The AISC Quality Certification Program will confirm that the AISC certified shop has the personnel, organization, experience, procedures, knowledge, equipment, capability and commitment to produce fabricated steel or stainless steel of the required quality for the wastewater treatment equipment.
 - 2. AWS Certified Welding Inspectors (minimum 2 on staff) shall conform to all standards, current or previous as listed in section 6.1.4 AWS QC1, Standard and Guide for Qualification and Certification of Welding Inspectors.
 - 3. AWS Non Destructive Testing Inspectors (Level I, II, III) for Magnetic Particle and Ultra-Sonic testing (minimum 2 on staff) shall conform to all standards, current or previous as listed in and in conformance with The American Society for Non-Destructive Testing (ASNT-TC-1A).

2.11 SPARE PARTS

- A. Furnish lubricating materials to allow for one year of operation. Lubricating materials shall be as recommended by the manufacturer.
- B. One set of all special tools, as required, shall be included and supplied by Manufacturer.
- C. The following Spare Parts shall be included, at a minimum, and supplied together with the equipment:
 - 1. One (1) Complete bottom bearing assembly
 - 2. One (1) Solenoid valve rebuild kit
 - 3. Two (2) cleaning brushes

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations.
- B. All equipment shall be shipped and delivered fully assembled, except where partial disassembly is required in order to conform to transportation regulations or for the protection of components.
- C. The Contractor shall be responsible for unloading of the machinery and shall have equipment on-site available at the time of delivery permitting proper hoisting of the equipment.
- D. Systems to be installed complete with all necessary connections, valves, pipes, and fittings.
- E. Contractor shall complete all electrical power and control connections as specified in Division 26.
- F. Contractor responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.
- G. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of significant deviations.
- H. Installation of the equipment shall be in strict accordance with the contract documents and the manufacturer's instructions and shop drawings. Manufacturer shall supply anchor bolts for the equipment. Contractors shall install the anchor bolts in accordance with the manufacturer's recommendations

3.02 STARTING AND ADJUSTING

- A. Manufacturer shall furnish the services of a factory-trained Service Engineer for two (2) trips including three (3) days to inspect the installation, carry-out the equipment start-up procedures, and provide training to the operators in how to effectively operate and maintain the equipment.
 - 1. Equipment shall not be energized, or "bumped" to check the electrical connection for motor rotation without the Service Engineer present.
 - 2. The Service Engineer shall make all necessary adjustments and settings to the controls. In particular, the Service Engineer shall verify the measurement relay setting and the initial water level setting for the screen.
 - 3. The Service Engineer shall demonstrate proper operation of screen. The screen shall operate automatically based on the water level.

3.03 COMMISSIONING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.
- B. Performance and operational testing period shall demonstrate that the auger screen have the ability to clean the screen at set upstream water levels, wash screenings, and produce dewatered screenings capable of meeting the paint filter test.
- C. Prior to final acceptance of the screen, three (3) tests shall be conducted according to the EPA Paint Filter Test as described in method 9095 of EPA Publication SW-486.
- D. Should the system fail to produce screenings capable of passing the "EPA Paint Filter Test", the manufacturer shall at its own expense make all necessary modifications to the equipment until such tests can be passed.

3.04 CLASSROOM AND DEMONSTRATION TRAINING

- A. Provide minimum four (4) hours of classroom training and four (4) hours of demonstration training by a qualified manufacturer's representative.
- B. Contractor shall record training via digital video camera so Owner can use again in the future.
- C. Contractor shall meet additional requirements as required in Section 01 79 00.

END OF SECTION 46 21 35

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SECTION 46 23 00
GRIT REMOVAL SYSTEM

PART 1 - GENERAL

1.01 REFERENCE STANDARDS

- A. UL 698A - UL Standard for Safety Industrial Control Panels Relating to Hazardous (Classified) Locations; 2022.

1.02 SUMMARY

- A. This section includes all labor, materials, equipment, and incidentals required to provide:

- 1. One (1) vortex-type grit removal unit and one (1) integrated grit cyclone and grit classifier unit that shall perform grit washing and grit dewatering for removal of grit particles from the influent wastewater as specified herein. The grit removal system must be complete and operational with motors, base plates, control equipment and accessories.
- 2. One (1) Discharge Chute.
- 3. The Manufacturer shall also provide installation inspection, field testing, startup and training, after the equipment has been installed by the Contractor. The unit shall be furnished and installed with all necessary accessory equipment and auxiliaries, whether specifically mentioned in these specifications or not, and as required for an installation incorporating the highest standards for the type of service specified, including field technician representation during start up of the unit, and instruction of the Owner's personnel in the care, operation and maintenance of all equipment.
- 4. The grit removal system shall be located in the Preliminary Treatment Building (PTB) in the main channel.

- B. Related Sections include:

- 1. Division 1 - General Requirements.
- 2. Division 26 - Electrical.
- 3. Division 40 - Process Interconnections.
- 4. Section 43 21 14 - Recessed Impeller Vortex Type Slurry Pumps .
- 5. Section 46 05 01 - Wastewater Equipment General Provisions .

1.03 REFERENCES

- A. Applicable Standards:

- 1. American Friction Bearing Manufacturers Association (AFBMA).
- 2. American Gear Manufacturers Association (AGMA).

3. American Iron and Steel Institute (AISI).
4. American Institute of Steel Construction (AISC).
5. American National Standards Institute (ANSI).
6. American Society for Testing and Materials (ASTM).
7. American Welding Society (AWS).
8. National Electrical Code (NEC).
9. National Electrical Manufacturers Association (NEMA).
10. National Fire Protection Association (NFPA).
11. Occupational Safety and Health Act (OSHA).
12. Underwriter's Laboratories (UL).
13. American Structures Painting Council (ASPC).

1.04 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00. In general, include detailed data covering specifications, drawings, materials, parts, motors, sizes, capacities, dimensions, weights, lifting points, parts list, spare parts, clearance distances, wiring diagrams, controls, and other accessories forming part of equipment for the complete operational system. The information shall include, but shall not be limited to the following:
 1. Certified shop drawings showing all details of construction, dimensions and anchor bolt requirements.
 2. Descriptive product literature and catalog cuts.
 3. Complete bill of materials for the equipment.
 4. Recommended spare parts list.
- B. Submit headloss calculations at peak hour and average day design flows.
- C. Furnish Manufacturer's field service reports under provisions of Section 01 33 00, reports covering start up, adjusting, commissioning, demonstration, and training.
- D. Submit operation and maintenance manuals and Manufacturer's instructions in accordance with Sections 01 33 00 and 01 78 23.
- E. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.05 DESCRIPTION OF WORK

- A. Provide:
 1. One (1) vortex grit removal unit sized to meet the ultimate peak flow condition provided in Section 2.04.

2. One (1) integrated grit cyclone and grit classification unit capable of grit washing and dewatering, and discharge chute sized to handle the grit load at the ultimate peak flow condition provided in Section 2.04.
- B. The grit removal unit shall be placed in a concrete tank and receive the incoming screened flow. The grit removal unit shall provide sufficient surface area, detention time, and vortex action to remove the specified grit particles from the specified peak flow and concentrate the grit in a sump at the bottom of the unit. The de-gritted effluent from the grit removal unit shall be discharged as shown on the Drawings.
 - C. The grit pump shall convey the concentrated grit slurry from the underflow of the grit removal unit to the grit washing and classification unit.
 - D. The integrated grit cyclone and classification unit shall receive the underflow from the grit removal unit. The grit cyclone unit shall be mounted above the classification unit and discharge the concentrated and washed grit slurry to the grit classifier unit. The de-gritted overflow shall be discharged upstream of the grit removal unit as shown on the Drawings.
 - E. The grit classifier unit shall receive the underflow from the grit cyclone and allow the washed grit to settle. A slow moving screw shall provide further dewatering and transport the grit to the point of discharge. The washed and dewatered grit shall be discharged to a dewatered grit dumpster complete with drain and hinged covers and supplied by Owner. The de-gritted overflow shall be discharged upstream of the primary grit removal equipment.
 - F. The grit removal system, grit pump and all appurtenances shall be supplied by a single supplier. Multiple manufacturers are acceptable as long as they are compatible and all under a single supplier or authorized sales representative. The integrated grit cyclone, classifier, and control panel shall be provided by a single manufacturer.
 - G. The system to be furnished hereunder shall be made by a Manufacturer regularly engaged in such work and who has furnished similar installations and had them in successful and continuous operation for a minimum period of ten years.
 - H. Data on performance testing, service history and operation of existing installations using the submitted equipment shall be made available to the Engineer, upon request, for use in determining that the grit removal components offered meets the intent of the contract, performance requirements and criteria stated in these specifications.
 - I. The grit removal unit technology shall be designed utilizing computational fluid dynamics (CFD) and field data to verify its flow regime, headloss and grit removal characteristics. Upon request, data on the computation methods used and generic simulation results shall be made available to the engineer.

- J. Units using apex valves shall not be accepted.
- K. All components of the grit removal system located in the building and dumpster area shall be designed to be suitable for operation in a Class 1 Division 1 environment.
- L. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the Grit System in accordance with the installation instructions provided by the Supplier. Once installed, the Grit Removal System shall be complete and operational with all control equipment and accessories as specified herein or as otherwise required for a fully functional and operational system. The Grit Removal System Supplier must clearly identify in detail all exceptions to the Services

1.06 QUALITY ASSURANCE

- A. Manufacturer shall be successful in the experience of manufacture, operation, and servicing of grit removal systems of type, size, quality, performance, and reliability equal to that specified for a period of not less than ten (10) years. The Manufacturer shall submit evidence of experience having supplied a minimum of ten (10) installations in North America of similar size to the proposed system.
- B. Supplier shall provide vortex grit equipment, cyclone unit, classifier unit, grit pump (Section 43 21 14), motors, gear reducers, controls, control panels, valves, and lifting attachments as a complete integrated package to ensure proper coordination, compatibility, and operation of the system. Integrated, common manufacturer components shall be test-run by manufacturers the fully assembled machine in his factory before shipment.
- C. In order to assure uniform quality, ease of maintenance, minimal parts storage, compatibility, integrity of the individual components, and provide the specified warranty for all components, it is the intent of these specifications that all equipment and components called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- D. The Contract Documents represent the minimum acceptable standards for the equipment for this project. Equipment shall conform fully in every respect to the requirements of the respective parts and sections of the Construction Drawings and specifications. Manufacturers shall modify, redesign, and furnish with special features or accessories, use materials or provide equipment with finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of this specification.

- E. Drawing layouts, item weights and specification language for the grit removal system is based on Lakeside Equipment Corporation, Bartlett, IL. Modifications, including but not limited to, process, mechanical, electrical and structural modifications, required for other approved manufacturer's equipment may be necessary and shall be included in the Contractor/CMAR's bid price.

1.07 PERFORMANCE TESTING

- A. The Owner reserves the right to request manufacturer to perform performance testing to document that the performance criteria have been met. If requested by the Owner, the Manufacturer shall submit test results to Engineer after testing showing results of performance testing. The costs of the performance testing shall be paid by the Owner if they decide to proceed with it and reimbursed by the Manufacturer if results find unit did not meet the required specifications.
- B. Representatives of the Engineer will observe the tests and collect a copy of the recorded data. The information collected will be used as a basis for determining acceptability of the Manufacturer's results. In case of conflict, interpretations and calculations made by the Engineer shall govern.
- C. The Manufacturer shall provide all equipment necessary to properly conduct the tests. Contractor shall supply the facilities to support the system supplier in conducting the tests.
- D. If the grit removal system fails to satisfy the specified grit removal requirements, the system shall be modified as required to produce an installation that will satisfy the requirements. The equipment shall be completely retested after modification. Modifications shall be provided, and retesting shall be performed at no additional cost to the Owner. All modifications, including structural or electrical modifications necessary to accommodate the modified equipment shall be made at no additional cost to the Owner.

1.08 DELIVERY STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Installation Contractor until required for installation. Materials shall be transported, delivered, stored and handled in accordance with manufacturer's instructions and the requirements of Section 01 65 00.
- B. Freight paid by equipment Supplier.
- C. Final delivery schedule shall be coordinated with the Contractor.

1.09 WARRANTY

- A. The equipment Manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of one (1) year

under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty. Multiple warranties for individual components shall not be acceptable unless components are from separate manufacturers.

- B. Warranty period shall begin after completion of performance and operation testing or after written acceptance of the installation by ENGINEER, whichever occurs earlier.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Vortex Grit Removal Unit
 - 1. Lakeside Equipment Corporation, SpiraGrit 270 Degree with Inlet Baffle.
 - 2. Smith and Loveless
- B. Integrated Grit Cyclone and Classifier
 - 1. Lakeside Equipment Corporation, Type W Grit Cyclone-Classifier
 - 2. Smith and Loveless
- C. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section. Any deviations without sufficient evidence proving equal or superior quality shall be rejected without further review or comment.

2.02 MATERIALS AND FINISHES

- A. Unless otherwise specified, equipment shall be manufactured from AISI 304L stainless steel shapes (rods, angles, and channels), pipes, and sheets. All mechanical parts shall be designed to handle the forces that may be exerted on the unit during fabrication, shipping, erection, and proper operation according to the operation and maintenance manual. All parts being partially submerged, sprayed, or in contact with grit or grit screenings shall be manufactured from AISI 304L stainless steel. Carbon steel grit classifier screw shall be acceptable.
- B. Materials
 - 1. All stainless steel used for the fabrication of the equipment shall conform to the following standards:
 - a. Plate and Sheet ASTM A 167 / ASTM A 240
 - b. Bar ASTM A 276 / ASTM A 479
 - c. Tube ASTM A 312
- C. Exterior Surfaces Finishes

1. All surfaces shall be free of sharp edges, weld spatter and residue. All welds shall be ground smooth.
2. All stainless steel surfaces shall be acid washed.
3. All non-submerged exterior surfaces shall be glass bead blasted to a uniform finish.

2.03 GRIT REMOVAL UNIT (GRU-1)

A. Design Data

1. Number of Units: 1
2. Size: Per Supplier—7-feet
3. Average Flow to Unit: 0.5 mgd with no more than ½" headloss
4. Peak Flow to Unit: 2.5 mgd with no more than 1" headloss
5. Inlet Channel Width: Per Supplier—1.25 feet (38.1 cm)
6. Effluent Channel Width: Per Supplier—2.50 feet (76.2 cm)
7. Underflow Connection: 4"
8. NPW Connection (if required): 1.5" NPT
9. Operation: Continuous
10. Operational Performance Guarantee:
 - a. Grit greater than 100 mesh: 95% removal

B. Operation

1. The vortex grit removal unit shall operate on the vortex principle and shall be capable of removing grit from raw waste or process water and depositing grit in a lower storage hopper while allowing light organic solids to pass through the process. The grit chamber hydraulics shall incorporate a toroidal flow path.
2. An internal rotating mechanism specifically designed to aid in the separation of sewage solids and grit shall be supplied. No moving parts subject to wear shall be located below the water surface.
3. The vortex grit removal unit shall handle all specified flow requirements up to and including the peak flow requirement. Decreases in efficiency at flows less than the design capacity will not be acceptable.
4. The vortex grit removal unit shall be circular with tangential entry. Entry to the grit removal unit shall be preceded by a sloped ramp built to the requirements of the Drawings and Manufacturer recommendations.
5. Flow shall travel 270 degrees before exiting the chamber as indicated on the Construction Drawings. Short circuiting of the grit chamber shall be prevented using a system of baffles or an annulus ring.
6. The upper section of the chamber shall direct grit and solids to the lower section through hydraulic scouring by an axial impeller or propeller. The hydraulic scouring shall simultaneously lift and discharge organic material while directing grit particles towards the lower storage hopper through openings.

7. A floor plate separating the upper and lower sections shall be included. The floor plate shall have openings not to exceed 3-inches that allow for grit to pass to the lower storage hopper. The propeller for vortex grit installations with a floor plate shall be set within 6-inches of the bottom of the upper section. Installations with sloping floors are acceptable in lieu of a separation floor plate provided an impeller is installed and the distance between the impeller and sloped tank wall is 2-inches.

C. Grit Chamber

1. The grit chamber shall be constructed of concrete and consist of an upper and lower section as indicated on the Drawings. The lower section shall be dedicated as a grit storage hopper. Grout shall be placed as shown on Drawings and per Manufacturer recommendation.

D. Motor

1. A 3-phase, 60 Hz, 460 volt helical gear motor suitable for use in a Class 1, Division 1 shall be used for rotating the drive tube. Maximum rated horsepower of the motor shall be 3/4 HP.
2. The motor shall not be overloaded under any normal operating conditions.
3. See Division 26 for additional Electrical requirements.

E. Mechanical Drive

1. A single drive tube shall be driven by a heavy duty iron spur tooth bull gear bolted to a turntable bearing. A heavy duty iron case shall house the spur tooth bull gear. The bull gear shall be driven by a heat-treated steel drive pinion mounted on the output shaft of the helical gear motor and shall rotate with a minimum 21-inch diameter turntable bearing for durability and stability. The turntable bearing shall have a minimum B-10 life of 20 years. All other bearings of the drive unit, including the motor, shall have a minimum B-10 bearing life of 100,000 hours. Pinion and bull gear shall have a service factor of 5.0 or greater at standard operating speeds.
2. The maximum output of the drive tube shall be 21 rpm and shall be driven by the iron tooth bull gear wheel bolted to the turntable bearing. The bull gear shall have an opening for the 10-3/4-inch drive torque tube that rotates all connected propellers, impellers, and/or fluidizing vanes.
3. The gearbox shall be designed specifically for wastewater applications. The gearbox shall be sealed and the bottom opening shall have an air bell around the torque tube to prevent water from entering the gear box.
4. Drive torque tubes shall be 304L stainless steel if they include the use of mechanical grit fluidizer vanes. Schedule 40 steel shall be the minimum

acceptable material for drive torque tubes not employing 304L stainless steel.

F. Propeller/Impeller

1. Propellers/impellers shall be supported and driven by the drive torque tube with no additional attachment points.
2. Propellers shall be axial flow, tapered, with generously rounded leading edge, to reduce energy consumption and prevent foreign material from fouling the propeller. Propellers shall be designed to direct grit particles into the lower storage hopper and to eject light solids from the tank. Propellers shall be 304L stainless steel.
3. Impellers shall be single flat disc plate with four equally spaced vanes fixed to the top side. The vanes shall be inclined back against the flow to induce radial forces necessary to promote grit particles falling by gravity to the storage hopper and a gentle upward current to eject light solids from the tank. A 4-inch opening behind each inclined vane shall allow light solids to re-enter the upper chamber following washing from the storage hopper. The impeller shall be supplied in two sections and shall be clamped to the drive tube. The performance of the impeller shall be adjustable by re-setting the vertical position of the impeller on the drive tube. Impellers shall be 304L stainless steel.

G. Floor Plate

1. Floor plates shall be included in installations as required by the Manufacturer.
2. Floor plates shall be two-piece, flat, and with an opening between the plate and drive torque tube no greater than 3-inch opening for grit to pass through to the storage hopper.
3. Floor plates shall be structural grade 304L stainless steel. Plate shall be sized per drawings, Manufacturer recommendations, and to effectively cover the lower section of the grit chamber. A minimum plate thickness of 1/4-inch shall be used.

H. Grit Fluidizer

1. Grit fluidizing shall be achieved either through mechanical vanes attached to the drive tube or through the use of water.
2. Grit fluidizer vanes, if required by Manufacturer, shall be located within 6-inches of the elevation of the pump suction inlet. The vanes shall be bolted to the propeller drive tube in a helical fashion. Vanes shall be fabricated from the same material as the drive tube (304L stainless steel).
3. Contractor shall supply and install a 1-1/2-inch diameter pipe that runs parallel with the suction piping and terminates in the storage hopper of the vortex grit chamber as shown in the Drawings should the vortex grit

manufacturer require a water fluidizing line. Contractor shall connect the pipe to a water supply that can provide flow and pressure required by Supplier. Water supply piping for grit fluidizing and/or flushing shall be required and installed by Contractor for all installations regardless of Manufacturer requirement.

4. If grit fluidizing through water is required by the Manufacturer, Manufacturer shall supply a 1-1/2-inch solenoid valve and two (2) manual isolation bronze ball valves for installation by Contractor per Manufacturer recommendation and Drawings. Manufacturer shall control the solenoid valve and therefore the fluidizing cycle through the grit system control panel. The ball valve downstream of the solenoid valve shall also allow for isolation for a downstream air tap (to be provided by Contractor) allowing for air use instead of water use in fluidizing and scouring. In instances where grit fluidizing with water is not required by the Manufacturer and is being included as a flushing line, Contractor shall supply a 1-1/2-inch diameter pipe for water connection with flow indicator, pressure indicator, and a two (2) manually operated ball valves – one on the upstream and one on the downstream side of the flow and pressure indicators – for isolation of air tap from the water supply line and gauge assemblies.
5. Water fluidizing line shall supply 15 to 20 GPM at 50 PSI.

I. Suction Piping by Installation Contractor

1. Suction piping shall be installed as shown on the Drawings.

J. Accessories

1. Baffle (Lakeside): A baffle system shall be installed. The baffle shall be an integral control baffle for both the inlet and outlet of the main chamber. The baffle shall be 304L stainless steel and designed to prevent short-circuiting and as a weir control device to control the water level in the main chamber. The baffle shall be installed by the Contractor using 5/8-inch anchor bolts.

K. Anchor Bolts

1. Equipment manufacturer shall furnish all anchor bolts located internal to the grit chamber of ample size and strength required to securely anchor each component. Anchor bolts, hex nuts, and washers shall be stainless steel. Anchor bolts shall be wedge or epoxy type.
2. Contractor shall supply all anchor bolts external to the grit chamber (e.g., drive motor mounting).
3. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.04 GRIT CYCLONE AND CLASSIFICATION UNIT (GCU-1)

A. Design Data

1. Cyclone

- a. Number of Units: 1
- b. Size: Per Supplier
- c. Performance: 95% removal of all grit
- d. (specific gravity 2.65) $\geq$ 106 microns in the flow range
- e. Influent Solids Concentration: $\leq$ 1.0%
- f. Influent Connection: 4" flanged pipe
- g. Maximum Flow/Unit: 250 gpm
- h. Inlet Pressure Range: 3 – 10 psi (68.95 kPa)
- i. Overflow Connection: 6" flanged pipe
- j. Underflow Connection 2" (Connected Directly to
- k. Classifier)
- l. NPW Connection: 1.5" NPT
- m. Vortex Finder Minimum Size: 3"
- n. Operation: Continuous

2. Classifier

- a. Number of Units: 1
- b. Screw Diameter: 12"
- c. Maximum Screw Speed: 12 rpm
- d. Performance: 95% removal of all grit
- e. (specific gravity 2.65) $\geq$ 105 microns in the flow range
- f. Conveying Capacity 303 feet (9235.44 cm)/hr
- g. Influent Solids Concentration: $\leq$ 1.0%
- h. Influent Connection: 2" (Connected Directly to
- i. Cyclone)
- j. Maximum Flow/Unit: Cyclone Underflow
- k. Dependent
- l. Minimum Pool Area: 4.02 feet (122.53 cm)
- m. Grit Discharge Connection: 3" x 5-1/2"
- n. Overflow Connection: 2-1/2" NPTF
- o. Tank Drain (Plugged) 2" NPTF
- p. NPW Connection: 3/8" NPTM
- q. Operation: Continuous

B. Operation

- 1. The grit cyclone and classification unit shall be an integrated unit designed to handle grit slurry underflow from the grit removal unit. The grit cyclone and classification system shall be designed to accept pumped flow as shown on the Drawings. The integrated unit shall be sized appropriately for the system and all components shall be hydraulically sufficient for the design conditions.
- 2. Inflow to the grit cyclone shall enter tangentially and shall separate the excess water on the constant rate vortex principle. There shall be no moving parts within the casing of the cyclone. The grit cyclone shall

separate the feed inlet into two streams: overflow and underflow. The overflow shall include the majority of the liquid along with lighter organic materials while the underflow shall be concentrated grit slurry which shall be directed into the grit classifier. Overflow piping shall be provided by the Contractor and installed upstream of the grit removal unit as shown on the Drawings. Cyclone underflow shall feed into the classifier for washing and dewatering and be sized so that the proper hydraulic loading is provided to the classifier. The grit classifier shall further remove organic material and shall separate the grit for discharge into a grit disposal system.

C. Grit Cyclone

1. The grit cyclone concentrator shall consist three main components: the main body, the vortex finder, and the outlet cone (apex).
2. The main body of the grit cyclone shall consist of a heavy-duty cast iron volute feed chamber with one fabricated steel or 304L stainless steel cylindrical section and apex (outlet cone) made of aluminum or 304L stainless steel.
3. The vortex finder shall be Ni-Hard. 304L stainless steel shall be acceptable.
4. Cyclone inlet feed shall be tapped for a 1-inch NPT gauge connection and a diaphragm protected pressure gauge shall be provided by the cyclone manufacturer.
5. Cyclone sections shall be individually lined and protected from the high velocity grit by a neoprene or polyurethane liner. The liner shall be replaceable.

D. Screw Classifier

1. The grit and water mixture will enter the screw classifiers 304L stainless steel flared inlet hopper that shall provide adequate volume to ensure that the inflow grit and water mixture has sufficient retention time for full separation of the heavy grit from the water and residual light organic solids. The inlet hopper will contain a maximum of two (2) overflow weirs to drain off the water which will be adjustable to allow precise control of the floatation and removal of light organic solids and to minimize the carry over of fine grit. The back of the hopper shall be fitted with a minimum 2-inch diameter drain connection.
2. The grit will be elevated from the hopper by a minimum 9-inch diameter ASTM A36 Carbon Steel screw with windings formed from 1/4 inch (6.35 mm) thick plate rotating in a 1/4 inch thick 304L Stainless Steel U-shaped trough set at a maximum 20 degree angle. The dewatered grit will drop from the plain end pipe outlet into the dumpster. The screw classifier will be self standing with 304L Stainless Steel support legs.

3. The screw conveyor shall be rigidly supported at both the upper and lower ends, so that the screw conveyor is mounted above, and does not contact, the classifier tank. This mounting shall provide for a clearance between the screw conveyor and the tank bottom, so that a buildup of sand or grit will provide a bed for the screw, eliminating tank wear, and providing a drainage area for the conveyed grit.
4. The top of the screw conveyor shall be connected in one of three acceptable manners. They are as follows:
 - a. Connection to a cycloidal motion speed reducer. The cycloidal speed reducer shall be designed so that all torque is transmitted by rollers, and shall be capable of withstanding shock loads of 500% of rated loading.
 - b. The top bearing shall be a self-aligning roller bearing suitable for the radial loading and also for the total thrust loading of the moving machinery. The bearing will be sealed for life and will not require maintenance other than regular inspection.
 - c. Direct-connected cycloidal-helical drive capable of withstanding shock loads of 500% of rated loading and designed for a minimum torque of 7,240 inch (183896 mm).-lb and a minimum thrust of 8,300 LBf at 12 revolutions per minute.
5. The bottom bearing will be specially designed for long life in a highly abrasive and submerged application. It shall be a self-aligning, sleeve-type bearing and designed to accept radial loads from the screw conveyor. The bearing shall be enclosed within a cast iron housing with stainless steel cap screws and fill and drain plugs and shall be submerged in oil and require only yearly inspection and infrequent oil changes. Bearings shall be provided with permanent satellite seals with hardened steel alloy rings held in place by a rubber toric to prevent oil leakage and infiltration of grit and other foreign particles into the housing.

Equipment utilizing continuous lubrication of grease in lieu of oil submergence shall use a 304L stainless steel housing. The grease flow acts as a lubricant to the bearing surface and creates a grease seal between the bearing and housing to further protect against the ingress of grit. Manufacturer's providing continuous lubrication shall provide the means for automation of the process including battery/inert gas driven automatic lubricator suitable for a Class 1 Division 1 environment. Equipment utilizing externally mounted, self-lubricated sleeve bearings packed with grease to prevent contamination shall also be acceptable.
6. Shaftless spirals shall not be considered equal and are not acceptable.
7. Screw classifiers designs with washwater options are acceptable and shall be required to provide the option. Washwater shall be acceptable to a maximum of three (3) gallons per minute and 50 psig (344.74 kPa). Manufacturers with washwater options shall supply solenoid valve as part of integrated unit on the water supply line as shown on Manufacturer drawings.

8. The classifier shall be removable from the unit through lifting and pivoting without disturbing or removing any other classifier components. Removal of the bottom bearing to remove the body of the screw classifier shall also be acceptable. Screw and cable-type lifting systems shall both be acceptable. For equipment utilizing externally mounted bottom bearings, a pivoting design shall not be required.

E. Motors

1. A 3-phase, 60 Hz, 460 volt helical gear motor suitable for use in a Class 1, Division 1 shall be used for rotating the drive tube. Maximum rated horsepower of the motor shall be 1.0 HP.
2. The motor shall not be overloaded under any normal operating conditions.
3. See Division 26 for additional Electrical requirements.

F. Discharge Chute

1. Manufacturer shall supply fabricated discharge chute which will attach to the grit discharge opening of the classifier tank. The discharge chute shall be fabricated from #12 ga. type 304L stainless steel in 5'-0" maximum lengths and shall extend to a depth as indicated by the Drawings.
2. Manufacturer shall provide a PVC tremie hopper (elephant chute) and attachment fitting to stainless steel discharge chute which shall end inside the cover of the screenings dumpster.

G. Anchor Bolts

1. Equipment manufacturer shall furnish all anchor bolts of ample size and strength required to securely anchor each item of equipment. Anchor bolts, hex nuts, and washers shall be stainless steel. Anchor bolts shall be wedge or epoxy type.
2. Anchor bolts shall be set by the Contractor. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

2.05 GRIT PUMP (GP-1)

- A. A grit pump shall be supplied by the same Manufacturer or Authorized Sales Representative as is supplying the vortex grit removal and grit cyclone and classifier units and be capable of successfully performing its intended use as part of the complete system. The pump shall meet the requirements of Section 43 21 14.

2.06 CONTROLS

- A. Control Panel

1. All controls necessary for the fully automatic operation of the grit removal system shall be provided. One (1) main control panel shall be furnished, UL certified, completely pre-wired and tested and placed in the electrical room per Drawings. One (1) NEMA 7 local control station rated for Class 1 Division 1 environments shall be placed next to the grit classifier unit as shown on the Preliminary Drawings.
 2. The main control panel shall adhere to the following specifications:
 - a. Enclosure Rating: NEMA 12
 - b. Material: Painted Steel
 - c. Voltage: 480 Volt
 - d. Phase: 3 Phase
 - e. Frequency: 60 Hz
 - f. Load: TBD
 - g. Logic: Allen Bradley Programmable Logic Controller
- B. The control panel shall contain all timers, starters, switches, indicator lights, and other components necessary to operate the following equipment:
1. One (1) grit removal unit (GRU-1).
 2. One (1) grit pump (GP-1).
 3. One (1) grit classifier unit (GCU-1).
- C. The main control panel shall be located in a climate controlled electrical room.
- D. The control panel shall have the following components. All components shall meet additional requirements of Process Control Panels And Hardware (Section 40 53 13).
1. Enclosure, NEMA 12, Painted, Wall Mounted.
 2. Main Non-Fused Disconnect, w/ door handle.
 3. Motor branch circuit protection.
 4. Motor Starter, - 10HP Grit Pump
 5. Control Power Transformer, 480-120VAC, w/Branch Circuit Breakers.
 6. PLC, Allen-Bradley CompactLogix. See Section 40 63 43 for PLC requirements.
 7. OIT, Allen-Bradley Panelview Plus 7 7.0-inch.
 8. Power Supply, 24VDC.
 9. Ethernet Switch: Allen Bradley Stratix 5700 Managed Switch, 8 ports w/two SFP slots.
 10. Uninterruptible Power Supply (UPS): 700VA or as required
 11. Lot, Pilot Lights.
 12. Lot, Pushbuttons.
 13. Lot, Selector switches.
 14. Lot, Door Mounted Speed POT.
 15. Lot, Socket Type, Control Relays.
 16. Lot, Terminal Blocks.
 17. UL 698A certification.

18. Door mounted elapsed time meters for the following:
 - a. Grit Removal Unit drive.
 - b. Grit Pump drive.
 - c. Grit Classifier Unit drive.
- E. The panel door layout shall include the following items:
 1. Front panel mounted main disconnect switch handle.
 2. Back lit, push to test power on indicating light.
 3. System alarm reset push button.
 4. Allen-Bradley PanelView Plus 7 color touch screen OIT with ethernet communications which will monitor and offer control of the following at a minimum:
 - a. Grit pump running
 - b. Grit pump hand-off-auto
 - c. Grit pump fail
 - d. Grit pump manual start
 - e. Grit pump manual stop
 - f. Grit pump flow rate
 - g. Grit classifier unit running
 - h. Grit classifier unit fail
 - i. Grit classifier unit manual start
 - j. Grit classifier unit manual stop
 - k. Grit classifier unit utility water (scour) hand-off-auto (if required)
 - l. Grit vortex unit running
 - m. Grit vortex unit on-off
 - n. Grit vortex unit fail
 - o. Grit vortex unit manual start
 - p. Grit vortex unit manual stop
- F. Local Control Station
 1. Provide a NEMA 7 local control station placed next to the grit classifier.
 2. The control station shall consist of the following:
 - a. Grit classifier unit hand-off-auto.
 - b. Emergency stop push-button (stops all three grit system items).
- G. The control panel(s) shall communicate with the Plant SCADA System utilizing the Ethernet/IP protocol over the Ethernet network.
 1. All controls, indicators, inputs/outputs, setpoints, timers, alarms, etc., shall be available for communication with the SCADA System for integration into the HMI and facility's control system. Provide the necessary data tables and coordinate all required data points with the SCADA System's programmer(s).

2.07 SEQUENCE OF OPERATIONS

- A. Screened raw wastewater shall be fed into the grit vortex unit continuously (24 hours per day).
- B. The grit vortex unit will turn on providing motion to the drive torque tube.
- C. The grit pump will start. If a water fluidizing line is required, the grit pump will delay for two minutes while the solenoid valve is set to the open position. The grit pump will start and the solenoid valve will close.
- D. The screw classifier will take signal from the grit pump to start and will run throughout the pumping cycle.
- E. Water scour selector switches will cycle water on/off in an automatic sequence per Manufacturer recommendation. The electrically driven automatic lubricator (if supplied) will start with the screw classifier and run throughout the cycle.
- F. The screw classifier will run on after the conclusion of the pumping cycle for 0-10 minutes.
- G. The screw classifier, water scour, and automatic lubricator (if supplied) will stop until the next pumping cycle.

2.08 SPARE PARTS

- A. The Manufacturer shall provide the Manufacturer's recommended spare parts and special tools. All parts and tools shall be suitably identified and effectively protected from moisture and corrosion with appropriate wrappings or coatings or a combination thereof.

2.09 UTILITY REQUIREMENTS

- A. Water
 - 1. Mechanical fluidization of grit in the grit removal unit shall be acceptable. Fluidization using water shall also be acceptable but the grit removal unit shall require no more than 20 gpm at 50 psig (344.74 kPa) for water fluidization.
 - 2. The grit pump shall require no external water source.
 - 3. The grit classifier unit shall require no more than 3 gpm at 50 psig (344.74 kPa).

2.10 SOURCE QUALITY CONTROL

- A. Each grit removal system and controller shall be factory tested to ensure satisfactory operation.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install all equipment per the manufacturer's recommendations.
- B. Systems to be installed complete with all necessary connections, valves, pipes, and fittings.
- C. Contractor responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.
- D. Contractor shall complete all electrical power and control connections as specified in Division 26.
- E. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of significant deviations

3.02 STARTING AND ADJUSTING

- A. Manufacturer's Service
 - 1. Provide services of an experienced, competent and authorized representative of Manufacturer for a minimum of two (2) days, eight (8) hours each. Additional Manufacturer services for starting and adjusting shall be the responsibility of the Contractor.
 - 2. Reference Division 01 for additional requirements.\
- B. Performance and Operational Testing (POT)
 - 1. Contractor shall be responsible for POT requirements in accordance with Section 01 91 00.

3.03 OPERATOR TRAINING

- A. Provide commissioning plan and meet additional requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.
- B. Prior to final acceptance of the grit removal system, three (3) tests shall be conducted according to the EPA Paint Filter Test as described in method 9095 of EPA Publication SW-486.
- C. Should the system fail to produce grit screenings capable of passing the "EPA Paint Filter Test", the manufacturer shall at its own expense make all necessary modifications to the equipment until such tests can be passed.

3.04 CLASSROOM AND DEMONSTRATION TRAINING

- A. Provide minimum eight (8) hours of classroom training and eight (8) hours of demonstration training by a qualified manufacturer's representative.

- B. Contractor shall record training via digital video camera so Owner can use again in the future.
- C. Contractor shall meet additional requirements as required in Section 01 79 00.

END OF SECTION 46 23 00

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SECTION 46 50 16
SEQUENCING BATCH REACTOR SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish and install the continuous flow Sequencing Batch Reactor (SBR) system per the Equipment Manufacturer's directions and the Drawings. The Contractor will complete all earthwork, forming, and concrete work required to install the unit. The plumbing/interconnecting piping, electrical connections, grating and handrails shall be provided by the Contractor as detailed on the drawings and specifications, including winterization such as piping insulation or heat tracing/heat tape. The Equipment Manufacturer will provide adequate protection of the equipment for shipment to the project site. Installation instructions will be provided that specifically outline installation of the SBR system. Lifting instructions will be provided to assist the Contractor.
- B. This Section includes all requirements for labor, materials, equipment, and incidentals required for installation:
 - 1. All materials and equipment for the SBR system, including systems components and appurtenances.
- C. The SBR system shall be complete and operational with all control equipment and accessories as specified.
- D. Related sections include:
 - 1. Division 01 – General Requirements
 - 2. Division 03 – Concrete
 - 3. Division 26 – Electrical
 - 4. Division 40 – Process Interconnections
 - 5. Division 43 – Process Gas and Liquid Handling, Purification and Storage Equipment
 - 6. Section 09 90 02 - High Performance Painting and Coating

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME)
- B. American Society for Testing and Materials (ASTM)
- C. American Society of Civil Engineers (ASCE)
- D. National Electrical Manufacturers Association (NEMA)
- E. Occupational Safety and Health Act (OSHA)

- F. American National Standards Institute (ANSI)
- G. American Iron and Steel Institute (AISI)
- H. American Institute of Steel Construction (AISC)
- I. American Welding Society (AWS)
- J. Where reference is made to one of the above standards, the revision in effect at the time of equipment procurement shall apply.

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00, detailed specifications, drawings, bill of materials, equipment weights, motor data, anchoring details and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.
 - 1. Submit, in addition to the shop drawings, the following:
 - a. Hydraulic calculations demonstrating compliance with the required hydraulic characteristics:
 - b. I/O schedule indicating tag number, type, ranges, and interconnection data for all instruments and devices.
 - c. Written performance guarantee.
 - d. Detailed layout drawings for all system components. Layout shall include elevation and plan view layouts for equipment, piping, and components. This shall include any supports, anchors, valves, weirs, and connections necessary to create a fully functional system.
 - e. Anchoring detail including the number, size, and spacing of the necessary anchor bolts, design weight, and design overturning moment.
 - f. Materials of construction for all major components.
- B. Manufacturer shall submit with shop drawings, a signed Affidavit certifying the process design criteria listed in this Section meets the Manufacturer's requirements for providing a complete wastewater treatment system capable of meeting the requirements of this Section.
- C. Submit Operation and Maintenance Manuals and Manufacturer's Instructions in accordance with Sections 01 33 00 and 01 78 23 .

1.04 DESCRIPTION OF WORK

- A. The system provided under this Section shall be suitable for continuous treatment of wastewater. It is the intent of this specification that the Supplier provides all equipment, materials, and appurtenances constituting a complete and operational SBR system, including, but not limited to:

1. Air Control Valves;
 2. Fine Bubble Aeration System;
 3. Submersible Mixers;
 4. Decant Mechanism;
 5. Process Control Equipment;
- B. Associated appurtenances including tank process equipment and piping, piping connections, and all components necessary to provide a fully functional system.
- C. The system shall be comprised of fine bubble diffusers, mechanical mixers, motor driven decant mechanism, and shall remove biologically degradable contaminants from the waste stream via activated sludge growth. This removal shall be accomplished by biological means alone and, provided proper levels of nitrogen, phosphorus, carbon, and alkalinity are present for biological stability, no chemical or chemical additives shall be required with the exception of metal salt addition for chemical precipitation of remaining reactive phosphorus.

1.05 DESIGN AND PERFORMANCE CRITERIA

- A. The System provided under this Section shall be designed for the continuous treatment of wastewater. Flow will be split between the system provided under this section and the existing SBR system. SBR2 shall treat one-half of the peak month flow and load during peak month conditions.
- B. Equipment shall be sized and laid-out to accommodate design flows and loads specified in this Section. It is entirely the responsibility of the SBR system Supplier to verify all design parameters. No allowance will be made for design errors or omissions that occur.
- C. Design flow and loading parameters are as follows:
1. Design Peak Flow: 1.0 MGD (0.5 MGD per SBR)
 2. Design Peak Month Flow: 0.8 MGD (0.4 MGD per SBR)
 3. Average Day BOD Load: 338 lb/day
 4. Peak Month BOD Load: 694 lb/day
 5. Peak Day BOD Load: 953 lb/day
 6. Average Day TSS Load: 492 lb/day
 7. Peak Month TSS Load: 716 lb/day
 8. Peak Day TSS Load: 2,668 lb/day
 9. Average Day TKN Load: 98 lb/day
 10. Peak Month TKN Load: 145 lb/day
 11. Peak Day TKN Load: 191 lb/day
- D. The System must be capable of treating wastewater to meet the following discharge limits:

Effluent Parameter	30 Day Average	Daily Maximum
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BOD5		10 mg/L	17.5 mg/L
TSS		10 mg/L	17.5 mg/L
% Removal (BOD and TSS)		85%	
E coli	May 1 - Sep 30	126 per 100 mL	236 per 100 mL
Ammonia-Nitrogen	Oct 1 - Aug 31	1.0 mg/L	1.75 mg/L
	Sep 1 - Sep 30	0.9 mg/L	1.75 mg/L
pH		6.6 < pH < 8.6 mg/L	
Nitrate-Nitrogen		50 mg/L	88 mg/L
Total Phosphorous			0.1 mg/L

E. SBR System Performance Guarantee

1. Supplier shall provide a Written Process Performance Guarantee to the Owner, guaranteeing the SBR system shall meet effluent wastewater quality and production quantity as defined in this Section.

1.06 QUALITY ASSURANCE

- A. The SBR wastewater treatment system, and appurtenances shall be furnished by a Manufacturer who shall have at least ten (10) years experience in the United States or twenty (20) years experience elsewhere in the design, production, assembly and field service of wastewater treatment equipment.
- B. The equipment supplier must have manufacturing and warehouse facilities located in the United States including parts inventory, and personnel based in the United States and employed by the supplier to provide direct technical and field support. The equipment Manufacturer must provide information supporting their ability to provide these services.
- C. To assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these specifications that all wastewater treatment equipment and accessories called for under this section shall be supplied by a single Manufacturer or authorized sales representative. The equipment Manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- D. Drawing layouts, item weights and specification language for the SBR wastewater treatment system assemblies is based on Sanitaire ICEAS SBR™. All engineering design, structural, electrical, mechanical, instrumentation and controls modifications necessary due to using a different Manufacturer shall be the responsibility of the Contractor at no additional cost to the Owner.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with the pertinent provisions of the delivery schedule. Coordinate delivery with Installation Contractor.
- B. Delivered materials shall be stockpiled and stored at locations approved by the OWNER until required for installation. Materials shall be transported, delivered, stored, and handled in accordance with manufacturer's instructions and the requirements of Section 01 65 00.
- C. Equipment and materials to be shipped F.O.B. shipping points, with freight prepaid to the jobsite. Fabricated parts when delivered to the site shall be stored off the ground and protected from weather and damage. Control and electrical devices shall be stored indoors.
- D. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.
- E. See additional requirements in Section 01 65 00.

1.08 WARRANTY

- A. The equipment Manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of one(1) years under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the Manufacturer's warranty.
- B. Warranty period shall begin after completion of the Performance and Operation Testing or after written acceptance of the installation by ENGINEER, whichever occurs earlier.

PART 2 - PRODUCTS

2.01 CONTINUOUS FLOW SEQUENCING BATCH REACTOR SYSTEM:

- A. Acceptable Manufacturers:
 - 1. Sanitaire ICEAS SBR
 - 2. Parkson Pisces CFSBR
 - 3. or Approved Equal
- B. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section.

2.02 AIR CONTROL VALVES

A. Scope of Work

1. The SBR supplier to furnish the following motor operated air flow control valves to control aeration in the SBR basins.
2. Valves shall be located in the basement of the existing process building.

Valve Location	SBR	
Valve Quantity	2	
Valve Diameter	8	inch
Actuator Power Supply	120/1/60	V/Φ/Hz
Actuator Type	Open/Close	

B. Construction – Valves

1. The valves shall be butterfly valves, wafer body style, EPDM-seat, tight-closing type for installation between two (2) ANSI Class 125/150 standard flanges.
2. The valves shall be rated at 50 psi (345 kPa) and provide drop tight shutoff at differentials up to 50 psi.
3. Valve bodies shall be cast iron (ASTM A126, Class B) and have two flange bolt guides to center the body in the pipeline. Valves shall be provided with power actuators.
4. The seat shall be tongue-and-groove design and act as a body liner to prevent flow from contacting the body casting. The seat shall also provide a positive seal without use of flange gaskets. Seats shall be of EPDM suitable for use with compressed air and shall be field replaceable.
5. The disc shall be aluminum bronze (ASTM B148-954). The disc-to-shaft connections shall be direct drive double “D” design requiring no disc screws or pins to connect shaft to disc. Outside diameter of disc shall be designed that when opened, it will not interfere with adjacent piping.
6. Shafts shall be one piece and shall be 416 stainless steel (ASTM A582 Type 416). Shafts shall be finish ground to minimize bearing and shaft seal wear. Shaft seals shall be provided to prevent leakage and to protect bearings from internal or external corrosion.
7. Valves shall be furnished with self-adjusting stem seal and non-corrosive Acetal bushings for smooth, low torque operation.

C. Construction – Electric Motor Actuators

1. All electric actuators shall conform to the requirements of AWWA Standard C-540.
2. Power actuated valves shall be furnished with electric motor actuators. The valve actuators are to be sized for design pressure with flow in reverse direction plus a 1.5 safety factor. The actuators shall include, geared travel limit switches, torque limit switches, manual

handwheel, condensation heater, terminals for motor power and controls and drive nut.

3. The motor shall be specifically designed for actuator service. The motor will be of the induction type with class F insulation and protected by means of thermal switches imbedded in the motor windings. Motor enclosure will be totally enclosed, non-ventilated.
4. The entire actuator enclosure should be NEMA 4 watertight.
5. Travel limit switches will be provided to de-energize the motor control circuit when the actuator reaches the limits of travel in the open and close directions.
6. Mechanical dial position indicator will be furnished on all valves.
7. The motor shall have an operating speed adjustment.

D. Acceptable Manufacturers

1. Valves shall be Bray Series 30 Resilient Seated Butterfly or approved equal.
2. Actuators shall be AUMA model SQ or approved equal.

2.03 FINE BUBBLE AERATION

A. Equipment Included:

1. Stainless steel droplegs, supports, and anchors.
2. PVC manifolds, air distributors, diffuser holders, and retainer rings
3. Bolts, nuts and gaskets for aeration system flange connections.
4. Air distributor purge systems.
5. Membrane disc diffusers with integral O-ring gaskets.
6. Cooling legs (if required).
7. Liquid purge system

B. System Design and Performance

1. Design aeration system around the following blower inlet volumetric flow rate at the specified submergence.

Parameter	Value	Unit
Blower Inlet Volumetric Air Rate	800	ICFM
Diffuser Submergence (@ AVE. Aeration Depth)	13.2	ft

2. Design air distributors with centerline spacing not to exceed 4 feet to maximize oxygen transfer efficiency and mixing efficiency and to minimize solids deposition between air distributors.

C. Materials, Fabrication and Finishing

1. Stainless Steel – Pipe, Fittings and Supports
 - a. Fabricate all welded parts and assemblies from sheets and plates of 304L stainless steel with a 2D finish conforming to ASTM A240, 554, 774, 778.
 - b. Fabricate non-welded parts and flanges from sheets, plates or bars of 304 stainless steel conforming to ASTM A240 or ASTM A276.
 - c. Welds & Welding Procedure
 - 1) Weld in the factory using latest standards according to AWS. Continuously weld both sides of face rings and flanges to eliminate potential for crevice corrosion.
 - d. Corrosion Protection and Finishing
 - 1) Preclean outside and finish clean all interior and exterior welds and piping by full immersion pickling and rinse with water to remove all carbon deposits and contaminants to regenerate a uniform corrosion resistant chromium oxide film per ASTM A380 Section 6.2.11, Table A2.1 Annex A2 and Section 8.3.

2. Natural Rubber – Furnish all fixed and expansion joint O-ring gaskets of natural rubber/SBR with a Shore A durometer of 45 ± 5 .
 - a. Polyvinyl Chloride (PVC) – Pipe and Fittings
 - b. Produce all PVC pipe and fittings from PVC compound with a minimum tensile strength of 48,000kPa.
 - c. Provide lower drop pipe, manifold and air distributors as follows:

Diameter	Wall Thickness	ASTM
4"	SDR 33.5	D3915, 3034, 124524
6" & larger	Schedule 40	D1784, D1785, D2466, 12454-B

 - a. Design air distributors and manifolds to withstand 54° C mean wall temperature.
 - b. Add two parts by weight of titanium dioxide per 100 parts of resin to PVC compounds for manifolds, air distributors, joints and PVC diffuser assembly components to minimize ultraviolet light degradation.
 - c. Factory solvent weld all PVC joints and fittings. Field solvent welding will NOT be permitted.

3. EPDM - Membrane Diffusers and Gaskets
 - a. Manufacture circular membrane diffuser discs with integral O-ring of EPDM synthetic rubber compound with precision die formed slits. Thermoplastic materials (i.e. plasticized PVC or polyurethane) are not acceptable.
 - b. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E.

D. Fine Bubble Aeration System Components

1. Droplegs - Provide a stainless steel dropleg from the air main connection to the dropleg connection on the manifold.
2. Manifolds – Provide PVC manifolds for connection to the air distribution headers.
 - a. Fabricate manifolds with 4 inch diameter fixed threaded union positive locking anti rotational or flanged joints for connection to the air distributors.
3. Air Distributors and Diffuser Holders - 4 inch diameter PVC air distributors perpendicular to the air manifold
 - a. Fabricate distributors with single diffuser holders solvent welded to the crown of the air distributor for complete air seal and strength.
 - b. Provide 4 inch diameter threaded removable end caps complete with gasket,, threaded coupling and end plate for clean out at the end of each distributor.
4. Air Distributor and Manifold Connection Joints
 - a. Join air distributor sections with positive locking anti rotational fixed threaded union or flange type joints for all submerged header joints to prevent blow apart and rotation.
 - b. Design flanged joints with a 150lb drilling angle face ring, follower flange and stainless steel hardware.
5. Supports- Provide each section of manifold and air distributor with a minimum of two (2) supports.
 - a. Limit maximum support spacing to 7.5ft.
 - b. Design all supports to allow for thermal expansion and contraction forces over a temperature range of 52° C and to minimize stress build up in the piping system.
 - c. Supports shall be adjustable to account for floor slope. Diffuser assemblies shall be level across tank.
6. Diffuser Assemblies - Furnish diffuser assemblies including diffuser, diffuser gasket, holder, retaining ring and air flow control orifice.
 - a. Membrane Diffuser
 - 1) Incorporate an integral check valve into the membrane diffuser.
 - b. Design and test diffusers for a dynamic wet pressure (DWP) of 12 inches $\pm$ 20% water column @ 1.0 SCFM/diffuser and 2 inches submergence.
 - c. Visual Uniformity – Observe diffusers for uniform air distribution across the active surface of the diffuser at 1.0 SCFM/diffuser and 2 inches submergence. Active surface is defined as the perforated horizontal projected area of the diffuser.
 - d. Quality Control – Test diffuser using primary sampling criteria outlined in Military Standard 105E.
7. Diffuser Holders and Retainer Rings
 - a. Design holder with air flow control orifice. Holder to provide peripheral support for the diffuser.
 - b. Design retainer ring to seal the diffuser and O-ring in the holder to prevent air leakage around gasket.

- c. Design retainer rings threads with minimum cross section of 1/8-inch and allow for one complete turn to engage threads.
8. Anchor Bolts
 - a. Provide a mechanical 304 SS expansion anchor bolts for embedment in 4000 psi concrete with a pullout safety factor of 4.
9. Liquid Purge System
 - a. Provide a liquid purge system to drain the entire submerged aeration piping system for each aeration grid including airlift purge eductor line and control valve. The purge system shall use a solenoid valve for automatic operation coordinated with the SBR operation.
10. Installation Procedures
 - a. Follow equipment manufacturer's recommendations and O&M manual for of equipment installation.

E. Approved Manufacturers:

1. Xylem Inc. Sanitaire Products
2. Parkson

2.04 SUBMERSIBLE MIXERS

A. Requirements:

Mixers per Tank	2	ea.
Submersible Cable Length	30	feet
Lifting Chain Length	25	feet
Motor Power Supply	460/3/60	V/Φ/Hz
Motor Power	4.0	HP

1. The mixer(s) shall be capable of handling raw, screened sewage. The mixer(s) shall be able to be raised and lowered and shall be easily removed for inspection or service without the need for personnel to enter mixing vessel or reactor tank. A sliding guide bracket shall be an integral part of each mixer unit. The entire weight of each mixer unit shall be guided by a single bracket which must be able to handle all thrust created by the mixer. Each mixer, with its appurtenances and cable, shall be capable of continuous submergence underwater without loss of watertight integrity to a depth of 65 ft.
2. Each mixer shall be of the integral gear, close coupled, submersible type. All components of the mixer, including motor and gearbox shall be capable of continuous underwater operation while the mixer blade is completely submerged.
3. All surfaces coming into contact with the mixed media, other than stainless steel and fiberglass, shall be protected by a factory applied spray coating of acrylic dispersion zinc phosphate primer with an epoxy finish coat on the exterior of the mixer.

4. Direct Driven: Major mixer components shall be of (304 Stainless Steel) construction. The oil housing cover plate shall be of corrosion resistant composite. All exposed fasteners shall be of stainless steel. In order to insure that the low velocity area around the motor remains impervious to low PH solids and or liquid attack, the motor housing exterior shall be made of 316 Stainless Steel.
5. Gear Driven: Major mixer components excluding blades and stand shall be of grey cast iron, ASTM A-48 Class 35B, or EN1561-GJL250 with smooth surfaces devoid of blow holes or other irregularities. The Sliding Bracket and mixer Stand assembly shall be 304 stainless steel. All exposed nuts and bolts shall be of 316 stainless steel.
6. Elastomers
 - a. All mating surfaces where watertight sealing is required shall be machined and fitted with a double set of Nitrile rubber or Viton O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between machined surfaces, resulting in controlled compression of the o-rings without requiring a specific torque limit. No secondary sealing compounds, rectangular gaskets, elliptical O- rings, grease, or other devices shall be used.
7. Cable Entry
 - a. Direct Driven: The cable entry housing shall be an integral part of the back plate. The cable entry shall have a double set of elastomer grommets in order to ensure a redundant system in the event of a cable entry failure. Single sealing systems will not be deemed acceptable. The cable entry shall be comprised of two cylindrical elastomer grommets, each flanked by washers and a ferrule designed with close tolerance fit against the cable outside diameter and the entry inside diameter. This will provide a leak proof seal at the cable entrance without the need for specific torque requirements. The assembly shall bear against a shoulder in the stator casing opening and be compressed by a gland nut threaded into it. Interaction between the gland nut and the ferrule should move the grommet along the cable axially instead of with a rotary motion. The junction chamber and motor compartment shall be separated by a terminal board which shall protect the motor interior from foreign material gaining access into the mixer top. Connection shall be made between the threaded compressed type binder posts thus securely affixing the cable wires to the terminal board. The use of the terminal compressed type post and a terminal board O-ring shall render the motor compartment leak proof from any liquid which may enter the terminal compartment.
 - b. Epoxies, silicones, or other secondary sealing systems shall not be considered acceptable.
8. Motor (Non-explosion proof)
 - a. Direct Driven: The multi-pole motor shall be directly connected to the propeller (gearbox designs are not acceptable). The mixer motor shall be squirrel cage, induction, shell type design, housed in an air filled, watertight chamber. The stator windings shall be insulated with moisture resistant Class H insulation rated for

180°C (356°F). The stator shall be insulated by the trickle impregnation method using Class H monomer-free polyester resin resulting in a winding fill factor of at least 95%. The motor shall be inverter duty rated in accordance with NEMA MG1, Part 31. The motor shall be designed for continuous duty, capable of no less than 30 evenly spaced starts per hours. The rotor bars and short circuit rings shall be made of aluminum. Thermal sensors shall be used to monitor stator temperatures. The stator shall be equipped with three (3) thermal switches embedded in the end coils of the stator winding and set for 284°F (140°C). These shall be used in conjunction with, and supplemental to, external motor overload protection, and wired to the control panel.

9. Propeller

- a. Direct Driven: The propeller shall be of 316 stainless steel, dynamically balanced, non-clogging backward curved design. Each blade shall be laser cut and welded to the hub to ensure that the propeller is properly balanced.
- b. Gear Driven: The propeller shall consist of two or three fiberglass-reinforced polyurethane blades, each integrated with a stainless steel shaft for mounting in a cast iron hub capable of handle changing hydraulic load conditions across their surface, thus shall capable of "flexing" and absorbing loads which would otherwise be transmitted to the gearbox and motor. Thus, metal blades will not be acceptable due to their inelasticity. Each blade shall be mounted into a socket in the side of the hub and will be held in place by a keyed propeller shaft to resist torsional forces, as well as a bolt and lock washer system along the axis of the propeller shaft. The blade shape shall be a nonclogging, backward curved design which starts at the hub leaving no part of the shaft exposed.
- c. The propeller shall be capable of handling solids, fibrous materials, heavy sludge and other matter found in normal sewage applications.

10. Bearings

- a. Direct Driven: All bearings shall have a minimum B-10 or L-10aa rated life of 100,000 hours and shall have inner and outer races of metal construction. Bearings with races made of nonmetallic construction will not be deemed acceptable or meeting the load handling and environmental requirements of this application. The outboard propeller bearing shall be an angular contact bearing. The motor shaft end shall be supported by two bearings. A roller and an angular contact ball bearing shall take up the axial and radial loads while an angular contact ball bearing shall take up the axial loads. The bearings shall be pre-loaded by a bearing loading nut located on the motor end of the shaft in order to reduce shaft deflection and increase bearing life and seal life. Mixers (and pumps) without pre-loaded bearings will not be considered acceptable or equal.
- b. Gear Driven: The mixer motor shaft shall rotate on two permanently lubricated bearings. The inner bearing shall be a

- single row deep groove ball bearing and the outer bearing a spherical roller bearing, both having 100,000 hours service life.
11. Mechanical Seals
 - a. Direct Driven: The standard inner mechanical seal is corrosion resistant Tungsten Carbide/Aluminum Oxide. The outer seal faces are Tungsten Carbide/Tungsten Carbide. One face of the inner seal ring pair shall have spiral grooves laser etched in it, to provide a pumping action to move leakage from the stator housing back into the oil chamber. In order to avoid seal failure due to sticking, clogging, and misalignment from elements contained in the mixed media, only the seal faces of the outer seal assembly and its retaining clips shall be exposed to the mixed media. All other components shall be contained in the oil housing. The mixer shall be equipped with a seal shield that prevents fibrous material from winding up around the shaft and outer seal. The shield shall be welded to the propeller hub and extend towards the motor. The shield shall rotate with the propeller and there shall be a radial micro-gap between the shield and oil-housing.
 12. Oil Housing
 - a. Direct Driven: The oil housing shall contain two compartments consisting of an inner and an outer section with four ports to connect and facilitate oil flow. In the event that the mixed media bypasses the other seal, this design will allow the outer compartment to collect the heavier (denser) fluids by means of a simple gravity process. Mixers which require propeller removal for oil change shall not be acceptable. Separate fill and drain plugs shall be provided to facilitate oil replacement.
 13. Gear Unit (for gear driven units)
 - a. The gearbox shall be a two-stage, cylindrical, helical gearbox equipped with high precision, low loaded gears designed for infinite life. The motor shaft shall be provided with an integral driving gear. The gearbox intermediate shaft containing the first driven gear shall mate with the motor shaft driving gear. The intermediate shaft shall rotate in two spherical roller bearings and contain the second driving gear. The propeller shaft shall contain the second driven gear and rotate in one single row and one double row, angular contact set of ball bearings.
 14. Mounting Mast Assembly (Direct Drive Mixers)
 - a. Mast shall be constructed of 304 stainless steel
 - b. Mast shall enable the operator to position and lock the mounting mast and mixer at different operating angles along the horizontal and vertical planes respectively.
 - c. Mixer mounting system shall be designed to accommodate tanks with sloped walls and floors
 - d. For deep tanks, mixer mounting masts will include the use of additional intermediate mast mounting brackets, preventing mast deflection.
 - e. For closed tanks, utilizing the adjustable 316 stainless steel cable, the mixer shall be supported at the desired operating level, allowing the davit's lifting cable to be slackened and removed from

the winch. This feature shall enable the portable davit to be removed from its mounting socket and stored, while the davit's lifting cable may be secured below the roof of the tank. This in turn permits the tank roof doors to be closed during mixer operation.

15. Davit and Winch Assembly

- a. A socket for mounting a portable davit crane shall be provided at each mast assembly station to raise and lower the mixer(s) [and pumps(s)] for installation and service. One (1) portable davit crane shall be provided, consisting of a lifting davit, winch, hook and 40 feet of 316 stainless steel lifting cable.

B. Acceptable Manufacturers

1. Xylem Inc. Flygt Products
2. Approved Equals

2.05 DECANT MECHANISM

A. Scope of Work

1. The SBR supplier to furnish decanter assemblies with drive actuator for one (1) SBR basin. The decanter shall be designed to remove clarified effluent.

Tank	SBR	
Decanter Quantity	1	
Decanters per Basin	1	
Decanter Weir Length	12	ft
Decanter Material of Construction	304L SS	
Actuator Quantity	1	
Actuators per Basin	1	
Actuator Power Supply	460/3/60	V/Φ/Hz
Actuator Power	3/4	hp

B. Design Parameters

1. The maximum decanter loading at Normal Flow condition shall not exceed 20 ft³/ft/min (1.8 m³/m/min). The maximum decanter loading at High Flow condition shall not exceed 30 ft³/ft/min (2.8 m³/m/min).
2. The decanter weir and trough shall always be visible from the basin side wall thereby providing the operator with a visual check of the effluent quality during the decant phase of the cycle.
3. The decanter shall be parked above the design top water level during aeration and settling phases, thereby eliminating any possibility of solids carryover during these phases.

4. At top park position, the decanter shall provide 'fail safe' overflow protection in the event of a power failure. Settled supernatant will flow via gravity, under the scum guard, over the weir, and into the decanters.
 5. The decanter shall be designed with a scum guard mechanism to prevent the discharge of scum and floatables during decanter or overflow operation.
 6. All in-basin seals and bearings shall be maintenance free.
 7. Decanter assembly components requiring routine maintenance shall be accessible from the walkway and shall not require confined space entry into the basin.
 8. The drive mechanism or actuator shall be designed for a continuous duty, variable speed mode of operation thereby producing a uniform effluent flow rate throughout the decant phase.
- C. Actuator limit switches and motor shall be integrated with process control system to prevent blower operation during the decant phase of the cycle.
1. The decanter assembly shall not require effluent valves, valve vaults, flex joints, throttling capabilities, or dewatering supports.
- D. Equipment
1. The decanters shall be supplied with the following components:
 - a. Upper collection trough with integral, overflow weir
 - b. Scum guard mechanism
 - c. Downcomer pipes
 - d. Collector pipe (for decanters >6ft)
 - e. Swivel Joint or Seals & bearings, as required
 - f. Electro-mechanical actuator
 2. The drive mechanism or actuator shall consist of an electro-mechanical screw jack with protective boot and end position limit switches.
 3. The motor shall be driven by a variable frequency drive with a dV/dt filter on the load side of the drive. The VFD will allow the controls to vertically lower the decanter at a continuous and uniform rate.
 4. The decanter shall not require spring loaded valves, flexible joints, and/or throttling effluent valves to control discharge rate.
 5. The decanter must be self-supporting when the basin is drained.
- E. Controls
1. Decanter shall be operated per the hydraulic controller described in the controls section.
- F. Materials

1. All in-basin welded decanter components, except seals and bearings, shall be constructed of corrosion and ultra-violet resistant stainless steel. All fasteners shall be constructed of stainless steel.
2. The decanter seals and bearings shall be constructed of maintenance free, synthetic materials for longest possible service life. All seals and bearings shall be shipped factory assembled, simplifying installation.

G. Fabrication and Finishing

1. All decanter welding must be conducted by welders certified under ASME Code 9.
2. All joints to be finish tested for integrity by either air pressure (3.0 psi) or dye penetrate methods.
3. All finished decanter units to be free of abrasions, damage, flaws, carbon contamination and discoloration. All weld burn and discoloration shall be removed with pickle paste. All stainless steel surfaces shall be passivated and shall have a pleasing and uniform passivated appearance. Decanters shall be power washed for final cleaning prior to shipment.

H. Acceptable Manufacturers

1. Xylem Inc. Sanitaire Products
2. Parkson DynaCanter

2.06 PROCESS CONTROL

A. Scope of Work

1. The SBR supplier to furnish a complete control system. This shall include a master control panel with a Graphic Operator Interface and Programmable Logic Controller.
2. Local control stations shall be included for the Decanters.
3. Motor Starters and Variable Frequency Drives shall be included integral to the SBR supplier control panel enclosure. Provide adequate space for VFD cable separation. See Drawings for intended equipment layouts.

B. Control Panel

1. The control panel will be UL listed and SCCR of 5kA symmetrical.
2. The control panel enclosure shall be a (NEMA 12 steel, located inside a climate-controlled building) enclosure with a flange mounted disconnect if three-phase power is required. The panel shall be made of 10-gauge steel and fully braced. The doors shall be heavy duty 3-point latching doors with a lockable handle. The master circuit breaker disconnect shall be on the far right, and be interlocked with the doors.

3. Control power shall be provided by a transformer if three-phase power is required. In addition, a voltage filter and surge protective device shall be used for PLC and HMI power supply. The voltage filter will combine active tracking technology with UL listed surge protection against the full spectrum of voltage transients and surges. It must continuously track the input AC line power and respond instantly upon detecting extraneous high frequency noise and high voltage transients. The device must be UL1449 and UL1283 listed.
4. All control voltage branch feeders shall be protected by circuit breakers or fuses.
5. Control relays shall be electromechanical with touch safe screw terminals
6. Motor starters shall be UL Listed as a self-protected control device type of combination starter. See Specification Section (26 28 13) for starter requirements. Motor starters to be installed and fully wired within control panel enclosure furnished by SBR supplier.
7. Variable frequency drives shall be UL Listed. See Specification Section (26 29 23) for VFD requirements. VFDs to be installed and fully wired within control panel enclosure furnished by SBR supplier.
8. Terminal blocks shall be high-density type, rated for 600 VAC, 30 amp minimum. Ten percent spare terminals shall be provided. All devices shall be clearly marked and identified on the inside of the panel. All terminals and wires shall be clearly tagged in accordance with the schematic and wiring diagrams.
9. Pilot lights shall be industrial Monolithic style, 22mm devices, or equal. A "Hand-Off-Auto" switch will be provided for each motor. Selector switches shall be industrial, NEMA 4/13, 30mm, water/oil tight devices. The Auto position will allow automatic PLC operation while the Hand position will allow the operator to bypass the PLC when operating equipment.

C. Programmable Logic Controller (PLC)

1. The Programmable Logic Controller (PLC) shall have a built in Ethernet port for network communications.
2. Acceptable Manufacturers:
 - a. Rockwell Automation / Allen-Bradley CompactLogix
 - b. Approved Equal
3. See Specification Section (40 63 43) for PLC requirements.

D. Human Machine Interface (HMI)

1. A Graphic Operator Interface Terminal (HMI) shall be mounted on the front of the panel for control of the SBR as a means of controlling the system and shall provide graphic display of the process parameters and equipment status on a color display. The HMI shall also allow for entry of setpoint changes for system control. The display shall be 15" widescreen touchscreen.

2. Minimum HMI functions shall include:
3. Graphical display of all status information available for each device in the biological treatment system in the form of a pop-up window for quick and easy access.
4. Display all smart sensor status information available from the sensors.
5. Easy navigation set up with control mode select buttons for each basin along the left and HMI screen navigation buttons along the top.
6. Acceptable Manufacturers:
 - a. Rockwell Automation / Allen-Bradley PanelView Plus
 - b. Approved Equal

E. Remote connection

1. A webport with a built in four-port Ethernet switch shall be provided to allow direct access for online technical support via a standard internet connection.
2. A customer account shall be set up by the supplier to allow operations staff access to view the plant HMI.

F. Control Logic

1. The SBR controls shall operate on a time cycle basis. The process elapsed time will be displayed on the display terminal. Each pair of SBR tanks will operate on a complimentary basis, so that while one tank is in aeration the other tank is in settling or decant phase. The cycle will automatically adjust for high flow conditions to increase the throughput capacity in high flow conditions. In automatic operation, the processor shall at all times maintain the proper sequence of operation even in the event of power failure. All phases of the process and equipment shall be interlocked so that the process cannot be upset. If an equipment failure takes place an alarm will be displayed on the operator terminal until cleared. The display will indicate the time of the alarm and status.
2. Time critical sequences and other process variables can be adjusted via the operator interface terminal as follows:
 - a. SBR Sequences shall consist of [1] Aeration blower run time, [2] The waste sludge pump start time and running time, [3] The decanter lowering rate, and [4] Special process variables such as DO setpoints if required.
3. The control system will include the following controllers, as well as instruments for monitoring process parameters, as detailed subsequently in this specification:
 - a. Hydraulic Controller
 - b. Decanter Controller
 - c. Aeration Controller, including Aeration Valves
4. Acceptable Manufacturers
 - a. Xylem Inc. Sanitaire Products
 - b. Parkson

G. Instrumentation and process control

1. Scope of Work

- a. The SBR supplier to furnish, configure and commission the instrumentation for the SBR system. In addition, the SBR supplier shall furnish the control algorithms and instrumentation detailed below to control the process:

	Location	No. per Zone	Total Count
Terminal/Controller	Transferable	-	1
DO	Aerated Zones	1	1

1. Terminal/Controller

- a. The analyzer shall be a digital multi-channel, multi-parameter system capable of controlling up to 20 sensors, in any combination, for the determination of water and wastewater parameters.
- 1) The controller must be configurable to include the following measurements: COD, TOC, DOC, SAC, BOD, pH, ORP, NH₄-N, NO₃-N, PO₄-P, Conductivity, DO, Turbidity, TSS, Temperature and Sludge Level Monitor.
- b. The controller shall receive 4 to 20 mA signals from third party instruments.
- 1) Communication between controller and sensor shall be digital, allowing cable runs up to 3,000 feet without further amplification.
- 2) The system will provide up to 20 programmable analog outputs (max. load 500 ohms) and 20 programmable alarm relays (rated to 5A at 250VAC). System shall also be capable of Ethernet/IP communication.
- 3) 90VAC-264VAC power required.
- 4) Enclosure is NEMA-4X rated.
- 5) Entire system including the sensors shall have built in lightning and surge protection.
- 6) Ambient operating temperature -20°C to +55°C.
- 7) System diagnostics shall be standard.
- 8) System shall also have a USB interface port, data storage capability, and 3 levels of security.
- 9) System must have integrated lightning and overvoltage protection.

10) Backup controller function to increase reliability.

- c. The terminal controller shall be YSI/WTW model 2020 IQ Sensor Net.
- d. All instruments associated with the biological system must be connected to the terminal/controller communication network back to the Control Panel.
 - 1) Universal Mounting Kits with all necessary hardware shall be provided for each sensor.
- e. A sunshield and mounting bracket shall be provided for the system display/controller and each local component to be mounted outside.

H. Hydraulic Controller

1. Description of controller

- a. The hydraulic controller is used to adjust the cycle time to accommodate increased flow events while maintaining treatment objectives.
- b. The hydraulic controller shall automatically switch back into a normal mode of operation once the hydraulic threshold has been maintained and an additional cycle has been completed.
- c. The hydraulic controller shall interface with the aeration controller to increase the settling time to minimum of 30 minutes during the high flow conditions.
- d. Include an integral safety feature interlocking the aeration and mixer controllers to prevent solids carryover in the decanter.

2. Instrument specification

- a. SBR basin shall be equipped with a level transducer. The level transducer shall have a PPS body with a ceramic diaphragm. The transducer shall be cable mounted and factory calibrated for the basin depth. The transducer shall be a 2-wire type and produce a 4-20ma signal in direct proportion to the measured level.
- b. The level transducer shall be a Xylem Inc, Products model MJK Expert™ 3400
- c. SBR basin shall be equipped with a high level non-mercury float switch.
- d. The float shall be a Xylem Inc, Flygt Products Model ENM-10.
- e. Level signals and level indication shall be used to control the high flow cycle time and to reduce the aeration time in case of extreme high flows.

I. Decanter Controller

1. Controller description

- a. Decanters shall be used to remove effluent from the SBR basins during the decant phase of the system cycle.
- b. The decanter controller uses an algorithm to descend the decanter weir throughout the cycle at a constant vertical rate ensuring a constant discharge flow rate.

- c. The decanter controller ensures proper synchronization between process decant time and weir position prior to the next phase starting to prevent solids contamination in the decanter effluent.
- d. When not at design flow the decanter idle time is at the beginning of the decant cycle to maximize settling time.
- e. Decanter speed will be controlled by a Variable Frequency Drive (VFD by others) which controls the speed of the decanter actuator motor.
- f. Shall ensure the decanter is above the water level prior to aeration of the tank such that solids cannot carryover the decanter 100% of the time during the transition from decant to aeration phase of the cycle.
- g. Ensure that existing SBR and new SBR2 do not decant at the same time.
- 2. System Components
 - a. Decanter mechanism – as described in mechanical section of this specification
- 3. Linear actuator – as described in mechanical section of this specification

J. Aeration Controller

- 1. Description of the controller
 - a. The aeration controller is used to reduce energy and optimize process stability by maintaining the desired dissolved oxygen setpoint during aerobic phases of the react phase.
 - b. The aeration controller algorithm shall switch between modes of operation and make process control adjustments and decisions based on diagnostic information that tests the integrity of the data and utilizes fault indications from the sensors.
 - c. The intent of the multiple modes of operation is to protect the process operation when instrumentation has faulted or is in need of maintenance.
 - d. Ensure that existing SBR and new SBR do not require aeration at the same time.
 - e. Open/Closed control of manufacturer supplied aeration valves.
- 2. Dissolved Oxygen Probes
 - a. Each SBR reactor installed shall be equipped with a dissolved oxygen probe.
 - 1) Communication to controller shall be digital.
 - 2) Connection to IQ Sensor Net shall be through a Xylem Inc. YSI/WTW SensorNet cable.
 - 3) The sensor shall be calibration free using intelligent membrane technology.
 - 4) Membranes shall last up to two years with replacement membranes containing calibration data chip.

- 5) Sensor shall use soft green fluorescent light with calibrated optics and equal path reference system.
- 6) Sensor shall have a measuring range of 0-20.00 mg/l.
- 7) Sensor shall integrated temperature measurement and compensation.
- 8) Temperature operating range of -5° C to + 50° C and measuring range of -5° C to + 50° C.
- 9) System accuracy shall be $\pm 0.05 \text{ mg/l} < 1.00 \text{ mg/l}$, $\pm 0.1 \text{ mg/l} > 1.00 \text{ mg/l}$.
- 10) Sensor shall include self-diagnostics.
- 11) Approved Manufacturer:
 - a) YSI/WTW model FDO 700 IQ
 - b) Approved Equal

2.07 ANCHOR BOLTS

- A. Contractor shall provide anchor bolts of ample size and strength required to securely anchor each item of equipment in accordance with equipment Manufacturer's requirements. Bolts, washers and hex nuts shall be AISI Type 304 stainless steel unless noted otherwise. Anchor bolts shall be adhesive-type stainless steel.
- B. Anchor bolts shall be set by the Contractor using templates provided by the equipment Manufacturer. Equipment shall be placed on the foundations, leveled, shimmed, bolted down, and grouted with a non-shrinking grout.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall install the SBR system per the Manufacturer's directions and the drawings. The Contractor will provide all supports and anchoring required to install all SBR system components. The plumbing/interconnecting piping, aeration interconnections, electrical connections, grating and handrails shall be provided by the Contractor as detailed on the Drawings and Specifications. The Manufacturer will provide adequate protection of the equipment for shipment to the project site. Installation instructions will be provided that specifically outline installation of all equipment. Lifting instructions will be provided to assist the Contractor.
- B. Installation contractor will conduct functional testing as defined in Section 01 91 00.

- C. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of significant deviations.

3.02 INSTALLATION

- A. The Manufacturer shall furnish the services of a factory-trained representative based in the United States and employed by the Manufacturer, for a minimum of fifteen (15) working days, not including travel days, and three (3) separate trips.
 - 1. A representative of the Manufacturer shall inspect the installation. The Owner shall be advised in writing of any corrections or adjustments that are required for the SBR equipment installation. After the SBR installation has been completed to the supplier's satisfaction, a letter of certification that all equipment is installed in accordance with its instructions and that the SBR equipment is ready for operation shall be furnished.
- B. The Contractor will provide to the Manufacturer a minimum prior notice of three (3) weeks to schedule these services.
- C. In addition to the trips in 3.02.A, within one (1) year of startup, the Manufacturer shall provide one (1) trip for a total of one (1) 8-hour working day on site for post start-up inspection of the equipment and additional training.
- D. If additional service is required due to the mechanisms not being fully operational, at the time of service requested by the Contractor, the additional service days will be at the Contractor's expense.
- E. The purchasing Contractor shall install the SBR wastewater treatment system in accordance with the Installation Instructions manual provided by the Manufacturer.
 - 1. The Manufacturer shall provide these instructions prior to shipment of the plant equipment.
- F. Installation inspection, start-up, and operator instruction shall be coordinated with the Installation Contractor. All equipment must be in operating condition and ready for Supplier's Field Technician when called to the project location.
- G. Install all equipment per the Manufacturer's recommendations.
- H. Systems to be installed complete with all necessary connections, valves, pipes, and fittings. Contractor responsible for adequate number of fittings and appurtenances required to provide a complete and functional system that are not provided by the SBR system Supplier.

- I. Layout and install supports in accordance with Manufacturer's instructions and anchor setting plan.

3.03 STARTING AND ADJUSTING

- A. Supplier shall provide starting and adjusting services, including but not limited to, required adjustments, test, operation checks and other start up activities.
- B. Inspect equipment for cleanliness prior to start up.
- C. Confirm equipment is properly anchored and supported.
- D. Reference Sections 01 45 00, 01 75 00, 01 91 00, and 46 05 01 for additional requirements.

3.04 PERFORMANCE AND OPERATIONAL TESTING

- A. Supplier shall provide assistance to Installation Contractor during Performance and Operational Testing.
- B. Final acceptance of equipment will not be provided until completion of 15-day Performance and Operational Testing (POT).
- C. Performance and Operational testing shall include, but not be limited to, the following:
 - 1. The test runs on the equipment and related systems shall be undertaken with water in the tanks filled up to the high water elevation shown on the Drawings. The Contractor shall be responsible for providing sufficient water, or treated wastewater for filling the tanks prior to arrival of Manufacturer's representative for the test runs on the equipment. The test runs on the equipment shall confirm acceptable normal running noise, speed and direction.
 - 2. Contractor shall provide utilities (power, compressed air, natural gas, etc. as required), permanent or temporary, for the duration of the functional test.
 - 3. In the event of improper installation, the Contractor and the Manufacturer shall be responsible for supervising the correction of the work and subsequent test runs until the defects are corrected.
 - 4. The Manufacturer shall provide the services of a qualified factory representative to perform tests during startup of full-load operation to verify that the equipment operates within acceptable vibration severity limits and to determine baseline vibration spectra for future use in identifying maintenance actions.
- D. Provide commissioning plan in accordance with requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of

Manufacturer's representative for functional and performance and operation testing (POT) if necessary for commissioning.

- E. Contractor shall provide utilities (power, water, compressed air, natural gas, etc. as required), permanent or temporary, for the duration of the POT test.
- F. Provide services of a Manufacturer's service engineer specifically trained on type of equipment specified for a minimum of three (3) days to assist with commissioning.
- G. Performance and Operation Testing period shall demonstrate that the SBR system as a whole will have the capacity to meet effluent limits in compliance with the WRRF's NPDES permit and the requirements of this Section. Contractor may be required to supply non-potable, dechlorinated water, micro and macronutrients, and carbohydrate-based food for microbial population.
- H. The 15-day POT test shall commence upon initial successful demonstration of meeting effluent limits and compliance with the requirements of this section.
- I. Contractor shall be responsible for establishing and maintaining an adequate microbial population in the aeration system during performance and operation testing.
- J. All safety systems shall be fully operational prior to POT.

3.05 MAINTENANCE AND SERVICE

- A. The local authorized representative shall have their own full time repair service available on 24-hour call. A factory serviceman and service vehicle equipped with the tools to make all necessary repairs, as well as component parts required to maintain satisfactory operation of the equipment, shall be available if needed, without undue delay.

3.06 CLASSROOM AND DEMONSTRATION TRAINING

- A. Supplier shall provide eight (8) hours of operator training by a qualified representative of the Manufacturer for Owner's personnel after system is operational. Training will occur on a schedule convenient to the Owner. Training will not take place while Manufacturer's representative is at the job site during start up or functional testing but may take place during POT. Ratio of classroom-time-to-demonstration-time shall be determined on training day by Buyer upon an as-needed basis to provide Buyer with satisfactory training.
- B. Training shall be of the on-the-job type and shall cover all areas of control, operation and maintenance for equipment furnished in this section. Training shall be provided by factory representatives.

- C. Contractor/CMAR shall record training via digital video camera so Owner can use again in the future.

END OF SECTION 46 50 16

SECTION 46 61 21
FUZZY FILTERS

PART 1 - GENERAL

1.01 SUMMARY

- A. Scope
- B. Provide all labor, materials, equipment, and incidentals required to furnish Fuzzy Filter® High Rate Filtration unit(s) with each consisting of filter vessel with influent, effluent, wash water, clean-out and drain connections; control valves; actuators; wash diffusers; perforated fixed and traveling media compression plates; traveling plate actuation system with limit switches; access hatch; media inspection port, sight ports; synthetic fiber compressible filter media; media wash blowers; manifold piping and valves; and controls. Each unit shall be complete and operational.
 - 1. Plant has one (1) existing Fuzzy Filter®. One (1) new filter will be added. The existing main/local control panel from the existing filter will be removed and replaced by new local panel. This panel will be installed/wired by the contractor. The new filter will be supplied with pre-installed main/local control panel. This new panel will control both filters. All required electrical and communication wiring will be installed by the contractor.
 - 2. The influent valve for the existing filter will be replaced by new modulating influent valve for flow control. Installation and wiring will be by the contractor. The influent valve and flow meter will be for modulating flow during backwash cycles. The design intent is to alternate flow between the two filters, not to have both filters run concurrently.
 - 3. Existing filter is not equipped with flow meter. New flow meter will be provided for the existing filter to be installed by the contractor. Required piping modification, installation and required electrical and communication wiring will be by the contractor.
- C. Related Sections include:
 - 1. Section 01 11 13 - Work Covered by Contract Documents
 - 2. Section 01 11 16 - Work by Owner
 - 3. Section 01 33 00 - Submittal Procedures
 - 4. Section 01 45 00 - Quality Control
 - 5. Section 01 61 00 - Common Product Requirements
 - 6. Section 01 75 00 - Starting and Adjusting
 - 7. Section 01 78 23 - Operation and Maintenance Data
 - 8. Section 01 79 00 - Classroom Demonstration and Training
 - 9. Section 01 91 00 - Commissioning

10. Division 03 - Concrete
11. Division 26 – Electrical

1.02 REFERENCES

A. Reference standards and associations include:

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).

1.03 SUBMITTALS

A. Submit for approval the following:

1. Shop Drawings: Furnish complete shop drawings in accordance with Section 01 33 00. Provide the following information and identify all other materials or equipment, dimensions, components, properties, and other information required to prove compliance with these Specifications.
2. Materials of construction for all major components.
3. Elevation and plan views of all components and assemblies showing configuration, construction, and dimensions.
4. Installation and leveling data.
5. Dimensions and required clearances.
6. Weights and forces.
7. A list of all deviations from drawings and specifications.
8. Submittals shall be provided in book-marked and searchable electronic format.
9. Operation and Maintenance Manuals: Submit Operation and Maintenance Manuals for approval. Refer to Section 01 78 23.
 - a. At a minimum, the following information shall be included:
 - 1) Manufacturer's instructions for equipment installation, startup, operation, preventative maintenance, servicing, and troubleshooting procedure. Test records, filter system data sheets, and final as-built drawings of all equipment. Name, address, and telephone number of factory trained service technician. Provide final Operation and Maintenance Manuals to Engineer. Refer to Section 01 78 23.
 - 2) Test records, filter system data sheets, and final as-built drawings of all equipment.
 - 3) Name, address, and telephone number of factory trained service technician.
 - 4) Provide final Operation and Maintenance Manuals, including any deviations, if any, to Engineer. Refer to Section 01 78 23.

1.04 WARRANTY

- A. The equipment Manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of one (1) year under normal use, operation and service. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the Manufacturer's warranty.
- B. Warranty period shall begin after completion of the Performance and Operation Testing or after written acceptance of the intallation by ENGINEER, whichever occurs earlier.

1.05 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: All equipment under this section shall be furnished by a single manufacturer. The manufacturer shall have a minimum of five (5) successful installations in the United States, with each having a minimum of five (5) years of operation.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Delivered materials shall by stockpiled and stored at locations approved by the OWNER until required for installation. Materials shall be transported, delivered, stored and handled in accordance with manufacturer's instructions and the requirements of Section 01 61 00.
- B. Comply with the pertinent provisions of the delivery schedule. Coordinate delivery with CMAR.
- C. Equipment and materials to be shipped F.O.B. shipping points, with freight prepaid to the jobsite. Fabricated parts when delivered to the site shall be stored off the ground and protected from the weather and damage. Control and electrical devices shall be stored indoors.
- D. Contractor shall inspect materials upon delivery for loss or damage in transit. Contractor shall be responsible for the replacement of damaged materials; damaged materials shall be removed from the Site.
- E. See additional requirements in Section 01 65 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Approved Manufacturers:
 - 1. Schreiber LLC, Trussville, Alabama

2.02 EQUIPMENT AND DESIGN CRITERIA

- A. Provide Fuzzy Filter® unit(s), with each suitable for filtering water under varying flows.
- B. On up flow gravity filters, the filter inlet and inlet piping is pressurized. In order to protect vessel and mechanism, maximum pressure at inlet must be limited to 8.2 psig. The filter inlet feed should be designed to incorporate a head box, overflow standpipe, or similar fail-safe pressure limiting device system to protect the filters.
- C. The media wash blower piping should be routed such that a portion of the piping is at an elevation higher than the filter water elevation.
- D. Design Criteria:

Application:	Municipal Wastewater	
Average design flow (ADF) to filter system:	0.25 MGD	174 gpm
Maximum design flow (MDF) per filter system:	0.60 MGD	417 gpm
Influent TSS:	30 mg/l	
Effluent TSS	10 mg/l	
Total Filter vessels:	1	
Filter Size:	3 ft	
Filter area (per vessel):	9 ft2	
Hydraulic loading at MDF:	27.7 gpm/ft2	
Hydraulic loading at ADF:	19.3 gpm/ft2	
Hydraulic loading with 1 filter in wash at ADF:	9.3 gpm/ft2	
Wash water rate:	10-20 gpm/ ft2	
Air wash rate minimum:	15 scfm/ ft2	
Air required for washing (per vessel):	135 scfm	
Number of vessels washing concurrently:	1	
Total air required:	135 scfm	
Number of Blowers:	1 (existing)	
Plate actuator HP:	2HP	

2.03 FILTER EQUIPMENT

- A. Outer Vessel:
 - 1. Each filter vessel shall be constructed of 1/4" Type 304 stainless steel. There shall be no sharp edges or rough welds.
- B. Filter Internal Equipment

1. Vessel internal components will be fabricated of 304 stainless steel.
 - a. The top and lower perforated media plates shall be 3/16" thick, with 1/2" diameter holes on 11/16" centers in a staggered pattern. Material: 304 Stainless Steel.
 - b. The wash diffusers shall be constructed of 304 stainless steel with drilled orifices.

C. Flow Distribution:

1. Influent flow distribution system shall consist of a hydraulic diffusion device, fabricated from 11GA 304 stainless steel, installed in the inlet plenum to provide uniform distribution to the media surface over the total range of flow conditions. Diffusion accomplished via 1/4" x 1 1/2" round end slots, 7/16" side bars, 3/8" end bars, long dimension of slots run parallel to length of cylinder, straight line centers. Provisions shall be made for removal of any large trapped solids within the flow distribution system. All edges of orifices shall be rounded for equal flow distribution.
2. The flow distribution device shall be arranged to allow flushing and back-flushing to remove accumulated solids. A manual butterfly valve shall be provided to serve as a blow-off for the flow distribution device. The device shall be completely removable from the vessel for cleaning.

D. Traveling Plate Actuation System

1. The traveling plate actuation system shall be fully capable of changing the position of the traveling media plate to expand and compress the media bed. The rising stem screw shall be capable of withstanding the internal pressures created by differential headloss, periodic pulsing and washing. Elevator actuator shall include:
 - a. Multi-turn screw jack gear box and TEFC, 460 V, 3 phase motor with integral starter, contactor, circuit protection and disconnect.
 - b. Position limit switches, and analog transmitter with digital readout system to identify the position of the traveling media plate shall be provided.
 - c. Traveling Plate Actuator shall be AUMA
 - d. Rising stem screw shall be 304 SS.

E. Filter Media:

1. Each filter vessel shall be provided with compressible synthetic fiber filter media.
2. Filter media shall consist of synthetic fibers bound into a quasi-spherical shape using clips to bind the fibers. Binding Clips shall be 316 Stainless Steel
3. In addition to the filter media for new filter, include replacement media for existing filter.

F. Filter Controls:

1. Controls Scope:
 - a. Filter Controls shall be provided to facilitate user selection and configuration of Fuzzy Filter operational features, automatically control the Fuzzy Filters during routine operation, and monitor the status and integrity of Fuzzy Filter componentry.
 - b. Automatic control of the Fuzzy Filters shall include the adjustment of flow into and out of each filter vessel, compression and release of media, media wash sequencing and associated valve control, operation of Media Wash Blowers, and the coordination of all connected Fuzzy Filters into one integrated system.
2. Controls Architecture: Enclosures and Panels shall be arranged as follows:
 - a. The new Fuzzy Filter so designated shall be equipped with a single 120 VAC Main+Local Control Panel, and a single 480 VAC Power Junction Box. The existing Fuzzy Filter(s) will be equipped with a single 120 VAC Local Control Panel, and a single 480 VAC Power Junction Box. New filter should be completely pre-wired as individual unit such that only one Ethernet communication cable, one 120 VAC power connection, and one 480 VAC power connection at the filter is required for interface between filters and with all respective mounted components. The local control panel for existing filter will be supplied loose to be mounted/wired and connected by contractor.
 - b. A Power Distribution Panel (PDP) shall be provided BY OTHERS, as needed.
3. Fuzzy Filter Main and Local Control Panel shall be provided with the following features:
 - a. NEMA 4X 304 Stainless Steel enclosure with 14 ga. steel subpanel housing 120 VAC and 24VDC components only, and suitable for use in temperatures from 15°F to 110°F.
 - b. Duplex GFCI x 120 VAC receptacle (mounted inside the enclosure).
 - c. 120 VAC surge suppression.
 - d. Power supply adequately sized to power all 24 VDC loads.
 - e. Operator Interface Terminal (OIT) to display system status and allow operator control. Operator interface shall be NEMA 4X Outdoor Rated and have a 7" diagonal color graphic touch display. OIT shall be PanelView Plus 7 or approved equal.
 - f. Programmable Logic Controller (PLC) shall be CompactLogix as manufactured by Allen-Bradley. Expansion I/O modules shall be provided as required.
 - g. Ethernet switch with copper RJ45 connections.
 - h. Control system shall be designed to allow remote support of the PLC and OIT via LAN or WAN when connected with appropriate peripheral hardware.
 - i. Pilot lights as follows, 30.5mm x NEMA 4X rated with white phenolic nameplate and black lettering:
 - 1) Control Power ON
 - 2) Common Alarm

- 3) Filter Alarm
 - 4) In Manual
 - 5) Washing
 - j. Selector Switches as follows, 3-position, 30.5mm x NEMA 4X rated with white phenolic nameplate and black lettering:
 - 1) Filter Mode "Manual-Off-Auto"
 - 2) Compression Screw "Down-Auto-Up"
 - 3) Influent "Open-Auto-Close"
 - 4) Effluent "Open-Auto-Close"
 - 5) Air Valve A "Open-Auto-Close"
 - 6) Air Valve B "Open-Auto-Close"
 - k. Fuses or circuit breakers to disconnect 120 VAC control power to field equipment.
 - l. Terminal blocks as required, 600 VAC x 30 amp rated, and capable of accepting a minimum of 22 to 12 AWG.
 - m. Labelled Wiring: All wires at each termination shall include self-laminating vinyl wire-number labels as manufactured by Panduit, PDL-1 or equal.
 - n. UL508A label.
- G. One (1) Fuzzy Filter Local Control Panel (to be mounted on existing filter by contractor) shall be provided with the following features:
- 1. NEMA 4X 304 Stainless Steel enclosure with 14 ga. steel subpanel housing 120 VAC and 24VDC components only, and suitable for use in temperatures from 15°F to 120°F.
 - 2. Duplex GFCI x 120 VAC receptacle (mounted inside the enclosure).
 - 3. 120 VAC surge suppression.
 - 4. Power supply adequately sized to power all 24 VDC loads.
 - 5. Remote expansion I/O modules as required, connected via Ethernet cable to system Programmable Logic Controller (PLC).
 - 6. Pilot lights as follows, 30.5mm x NEMA 4X rated with white phenolic nameplate and black lettering:
 - a. Control Power ON
 - b. Filter Alarm
 - c. In Manual
 - d. Washing
 - 7. Selector Switches as follows, 3-position, 30.5mm x NEMA 4X rated with white phenolic nameplate and black lettering:
 - a. Filter Mode "Manual-Off-Auto"
 - b. Compression Screw "Down-Auto-Up"

- c. Influent "Open-Auto-Close"
- d. Effluent "Open-Auto-Close"
- e. Air Valve A "Open-Auto-Close"
- f. Air Valve B "Open-Auto-Close"
- 8. Fuses or circuit breakers to disconnect 120 VAC control power to field equipment.
- 9. Terminal blocks as required, 600 VAC x 30 amp rated, and capable of accepting a minimum of 22 to 12 AWG.
- 10. Labelled Wiring: All wires at each termination shall include self-laminating vinyl wire-number labels as manufactured by Panduit, PDL-1 or equal.
- 11. UL508A label.
- 12. Fuzzy Filter 480 VAC Junction Box shall be provided with the following features:
 - a. NEMA 4X 304 Stainless Steel enclosure.
 - b. Terminal blocks as required, 600 VAC x 50 amp rated, and capable of accepting a minimum of 22 to 8 AWG.
 - c. Mounted near ground level.

H. Filter Control Valves:

- 1. Each filter vessel shall be provided with electric motor actuated control valves for the influent, effluent and the two (2) blower wash connections. The valves shall be Bray Series 30 with resilient seated wafer type butterfly valves with cast iron body and stainless steel stem and disk. Valves shall have EPDM seating surfaces and seals suitable for 250 degree F. service. The valve actuators shall be Bray 70 Series, or approved equal, one-quarter turn, open-close type, with output contacts to indicate open and closed positions. In addition, the influent valve actuator shall be provided with analog positional control and feedback to allow reduction of flow when required. Actuator motors shall be suitable for operation on 120VAC, 1 phase, 60 Hz service. Internal space heaters shall be provided inside each valve actuator to prevent condensation.
 - a. One (1) Influent valve: 6 Inch
 - b. One (1) Effluent valve: 6 Inch
 - c. Two (2) Air valves: 3 Inch
- 2. In addition, the following valves will be provided:
 - a. One (1) Manual cleanout/flush valve: 3 Inch
 - b. One (1) Manual drain valve: 2 Inch
 - c. Two (2) wafer style air check valves: 3 Inch
- 3. Include following for the existing filter
 - a. One (1) Influent valve (for existing filter): 6 Inch

I. Media Wash Blowers – Positive Displacement:

- 1. No blowers will be provided by the Fuzzy Filter supplier.

J. Pressure Sensor

1. Each filter vessel shall have a relative pressure sensor mounted below the lower media plate to determine the increase in pressure during a filtering cycle. The sensor is to be Efector PN Series as manufactured by IFM Electronics.
2. The sensor shall have a four digit readout for remote viewing. The pressure signal will be transmitted to the PLC in the main control panel which will be programmed to initiate wash cycles and other functions.

K. Flow Meter for Filter Control

1. Provide two (2) flow meters, one flow meter for each filter (existing and new filters) within the Filtration System to monitor each influent flowrate.
2. Flow meters should require minimal straight lay lengths up and downstream of the meter. Each filter has approximately 1'-8" of uninterrupted 6" diameter influent piping in which to install the flow meters.
3. Required features:
 - a. Operating Principle: Electromagnetic.
 - 1) Meters will be shipped loose. Required piping, pipe stubs and piping accessories shall be provided by contractor.
 - 2) Configuration: Flow meter shall have a controller with digital readout arranged in compact form directly on the sensor body. Controller housing shall provide for all wiring connections. Power supply to controller shall be 120 VAC. Output from controller shall be 4-20mA.
 - 3) Field Piping connections shall be flanged, Class 150, per ASME B16.5.
 - 4) Electrodes shall be 316L Stainless Steel.
 - 5) Liner material shall be (polyurethane rated for -4 to +122 °F / PTFE rated for -4 to +194 °F).
 - 6) Flow meter shall be sized such that fluid velocity shall not exceed 7 ft/sec at peak flow.
 - 7) Flow meter shall be Endress+Hauser, Proline Promag W 400 or approved equal.
4. The output from each filter-mounted Flow Meter shall be connected to the Filtration System Controls as a discrete analog input. The Filtration Control System shall be designed to incorporate values from the flowmeter as feedback to each filter's influent valve such that filter flowrate is maintained within user selected ranges during all filter

functions such as filtration, wash and purge for the purpose of maximizing filter efficiency and minimizing wash water reject rate.

5. In addition, the Filtration Control System shall be designed to sum the values from all filter-mounted flow meters to compute the total influent flowrate entering the Filtration System. The Filtration Control System shall be designed to allow matching of the quantity of filters in service to the computed total system flow under both filtration and wash conditions based on user selected thresholds.

2.04 CORROSION PROTECTION

- A. All motors, gear reducers, blowers, valves, and bearing housings shall be coated with the respective manufacturers standard machinery enamel.
 1. All motors, gear reducer, bearing housings, shall be coated with the respective original manufacturer's standard machinery enamel.
 2. The filter vessel, media plates, plate actuation system, wash diffusers and media shall be factory installed.
- B. All fabricated parts shall be Hot Dipped Galvanized unless noted otherwise.
- C. No stainless steel, aluminum, rubber, or neoprene shall be coated.

2.05 PIPING, FITTINGS, AND VALVES

- A. Filter Piping and Fittings:
 1. Orientation as shown on the Drawings. Supplier shall note configuration, layout, and elevation of all pipe and fittings for coordination with related filtration equipment.
- B. Valves:
 1. Filter function valves and aerator influent valves shall be electrically and manually actuated as shown on the Valve Schedule and Drawings. Valve size shall be as shown on the Drawings and included within the Valve Schedule.

2.06 REPLACEMENT MEDIA

- A. Filter manufacturer shall supply replacement media for all existing fuzzy filter media.
- B. Provide same replacement media as provided with new fuzzy filter.
- C. Provide manufacturer instructions for media replacement.
- D. Contractor to properly dispose of existing media.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation of equipment shall be by the Contractor.
- B. Equipment and accessories shall be installed in accordance with Contract Documents and Approved Shop Drawings; and consistent with Manufacturer's recommendations.
- C. All final electrical connections to be made by the General Contractor.
- D. All field wiring used to interconnect components to Filter Panels shall be as follows:
 - 1. For DC signals requiring two (2) conductors use Belden 8760 or equal.
 - 2. For DC signals requiring three (3) conductors use Belden 8770 or equal.
 - 3. For AC control and DC power and control wiring to components, use No. 16 AWG minimum stranded wire with thermoplastic insulation type MTW rated for 600 Volts and 90°C.
 - 4. For AC power wiring to components, use No. 12 AWG minimum stranded wire with thermoplastic insulation type MTW rated for 600 Volts and 90°C.
 - 5. Clearly number all wires at each termination. Labels shall be self-laminating vinyl labels as manufactured by Panduit, PDL-1 or equal.
- E. Installer shall obtain and provide the owner with an installation certificate signed by the equipment manufacturer's representative attesting that the equipment has been properly installed and is ready for start-up and continuous operation.

3.02 FILTER WASH TROUGH INSTALLATION

- A. All trough mounting brackets, hardware, and stabilizers shall be Type 304 stainless steel and shall be supplied by the manufacturer.
- B. Troughs shall be installed at the elevation shown on the Drawings. Trough weir edges shall be level to within $\pm 1/16$ inch.
- C. Seal all wall-trough and flume-trough interfaces water tight with appropriate flexible sealant.

3.03 FILTER TECHNICAL DIRECTION

- A. Filter manufacturer shall provide the following on-site services:
 - 1. Filter Equipment Installation Supervision: 1 day. Shall be separate trip from start up and training visits.
 - 2. Filter Mechanical Startup Supervision and Inspection: 1 day.

- a. Inspect the final installation to assure proper installation, connection, and wiring of all equipment of the manufacturer's supply.
 - b. This shall be a separate trip from the Installation Supervision services.
- 3. Process Startup Supervision and Training: 1 day.
 - a. Training shall include:
 - 1) Instruct Purchaser in the operation of the equipment provided under this item. All procedures shall be covered including methods of setting and controlling equipment, and appropriate responses to fluctuating site conditions.
 - 2) Instruct Purchaser in the maintenance of the equipment provided under this item. All procedures shall be covered including preventative maintenance, and troubleshooting methods.
- B. Filter manufacturer technician on-site time shall be coordinated to ensure that said services are provided when the actual Work is being completed. Scheduling of on-site time shall be the responsibility of the Contractor and filter manufacturer and with the knowledge of the Engineer. Additional on-site inspection by filter manufacturer's technician due to lack of Contractor schedule coordination will be at the expense to the Contractor.
- C. Upon completion of the installation, the technical director shall furnish a certificate of compliance detailing that the filter materials have been installed in accordance with the manufacturer's instructions.

3.04 FILTER START-UP AND TRAINING

- A. On-site training of supervisors and shift operators shall be provided at the time of start-up to familiarize personnel with the equipment and to instruct them in day-to-day operations, preventative and regular maintenance, trouble-shooting techniques, response to emergency conditions, and equipment diagnostics.
- B. The responsibility of the Contractor and the factory service representative with regard to start-up shall be fulfilled when the start-up is complete, the equipment is functioning properly, operating personnel have been trained and the equipment has been accepted by the Owner.

3.05 PERFORMANCE AND OPERATION TESTING

- A. Provide commissioning plan in accordance with requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.

- B. Final acceptance of equipment will not be provided until completion of Performance and Operational Testing (POT).
- C. Performance and Operation Testing period shall demonstrate that the Fuzzy Filter meets the performance requirements of this specification for the duration of the POT. Successful demonstration shall be defined as meeting effluent limits as well as a fully functional system in automatic and manual modes.

3.06 FILTER POST START-UP ACTIVITIES

- A. Upon completion of their Work, the manufacturer's field technician shall submit to the Engineer, four (4) copies of a written report outlining the equipment start-up, names of Owner personnel trained, and a listing of any deficiencies of equipment or materials as a result of their inspection, adjustments, corrections, repairs, and start-up. The report shall include descriptions of the inspection, adjustments, corrections, and repairs made, and shall certify that the equipment:
 - 1. Has been installed per manufacturer's requirements.
 - 2. Has been started and placed on line.
 - 3. Has been tested per manufacturer's instructions.
 - 4. Operator personnel have been instructed and trained.
- B. Performance and Operational Testing shall be completed by the CMAR in accordance with Section 01 91 00.

END OF SECTION 46 61 21

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SECTION 46 66 10
ULTRAVIOLET DISINFECTION EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

- A. Requirements for providing equipment and appurtenances required for an open channel, gravity flow, low pressure high intensity ultraviolet lamp (UV) disinfection system complete variable output lamp drivers. The UV system shall be complete and operational with all control equipment and accessories as shown and specified herein. This system will be capable of disinfecting effluent to meet the water quality standards listed in this section. UV disinfection Supplier shall provide installation, checkout, start-up, and training as described in this Section. The UV Supplier shall assist with functional testing and performance and operations testing as described in this Section.
- B. The UV disinfection Supplier shall provide the UV System Engineering and Design Services in support of the treatment system design as described in this Section.
- C. The Installation Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the UV System in accordance with the installation instructions provided by the Supplier. Once installed, the UV System shall be complete and operational with all control equipment and accessories as specified herein or as otherwise required for a fully functional and operational system. The System Supplier must clearly identify in detail all exceptions to the Services and Scope of Supply described in this Specification and include such list with their UV System proposal package
- D. Related Work Specified Elsewhere:
 - 1. Division 1 – General Requirements
 - 2. Division 26 – Electrical
 - 3. Division 40 – Process Integration
 - 4. Section 46 05 01 - Wastewater Equipment General Provisions.

1.02 REFERENCES

- A. Applicable Standards:
 - 1. NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse
 - 2. ASTM – American Society for Testing and Materials
 - 3. AISC – American Institute of Steel Construction
 - 4. NEMA – National Electrical Manufacturer's Association

5. NEC – National Electric Code
6. AISI – American Iron and Steel Institute

1.03 SUBMITTALS

- A. Shop Drawings and Product Data: Submit, in accordance with Section 01 33 00, detailed specifications, drawings, bill of materials, motor data, anchoring details and data covering all materials, parts, devices, equipment, and other accessories forming part of equipment for the complete operational system.
- B. Submit, in addition to shop drawings, the following:
 1. Hydraulic calculations demonstrating compliance with the required hydraulic characteristics.
 2. Independent bioassay validation and dosage calculations demonstrating compliance with the specified RED requirements.
 3. I/O schedule indicating tag number, type, ranges and interconnection data for all instruments and devices.
 4. Disinfection performance guarantee.
- C. Furnish Manufacturer's field service reports under provisions of Section 01 33 00, reports covering start up, adjusting, commissioning, demonstration, and training.
- D. Submit Manuals and Manufacturer's Instructions in accordance with Sections 01 33 00 and 01 78 23. Submit in electronic PDF format.
- E. The equipment Supplier shall provide a statement from the equipment Manufacturer in a letter stating that their package design and quality of workmanship is factory-approved and in no way will affect the equipment warranty provided by the Manufacturer. This letter shall be submitted with shop drawings.

1.04 DESCRIPTION OF WORK

- A. UV system shall be an open channel, gravity flow, low pressure high intensity ultraviolet lamp (UV) disinfection system complete with UV lamp modules, effluent channel, level control, UV monitoring system, power distribution receptacles, transition connections, a maintenance rack, assembly fasteners and related appurtenances.
- B. The UV system will be completely indoors.
- C. UV system shall contain a fully redundant UV bank.
- D. Design requirements with one bank in service:

Peak Flow	1.2 MGD
Total Suspended Solids	10 mg/L

Effluent Temperature Range	33-85 °F or 0-29 °C
Ultraviolet Transmittance @ 253.7 nm at Peak Hour Flow	65%
Effluent Standard to be guaranteed	126 E. Coli / 100 ml based 30 day Geometric Mean of consecutive daily grab samples

1. The UV system configuration will be as follows:

Number of Channels	1
Number of Banks per Channel	2
Number of Lamps in each UV Module	4
Number of UV Lamp Modules	12
Total Number of Lamps in the UV System	48
Number of UVI Sensors	1/bank
Serpentine Weir	1
Minimum Dosage, $\mu\text{Ws}/\text{cm}^2$ (MS2 basis)	30,000
Width Along UV Banks	Determined by Supplier
Width Along Weir	Determined by Supplier
Design Water Depth @ Influent	Determined by Supplier
Overall Channel Height	Determined by Supplier

E. Performance Requirements:

1. The ultraviolet disinfection system will produce an effluent based on the following:
 - a. 126 E.coli/100 ml, based on a 30 day Geometric Mean.
 - b. Grab samples will be taken in accordance with the Microbiology Sampling Techniques found in Standard Methods for the Examination of Water and Wastewater, 21st Ed. Sample collection and/or testing will be performed/paid by OWNER.
2. To ensure thorough characterization and reliability of the UV reactor, two challenge organisms will be used in the bioassay testing to bracket a range of pathogens with varying UV sensitivities in wastewater. One challenge organism will have resistance of 5 mJ/cm² per log inactivation (e.g., T1). The second challenge organism will have resistance of 20 mJ/cm² per log inactivation (e.g. MS2-phage). Use of two organisms will ensure inactivation of free-floating coliforms as well as harder-to-kill particle-associated coliforms and other pathogens of concern such as viruses.
3. To ensure accurate UV dose calculation, a sensor based control equation will be used to monitor real time lamp output to account for fouling and changes in UV intensity (ie due to lamp aging).

4. The UV system shall be designed to deliver a minimum MS2 RED of 30 mJ/cm² at peak flow, in effluent with a UV Transmission as described in Paragraph 1.04.D at end of lamp life (EOLL) after reductions for quartz sleeve fouling. The basis for evaluating the MS2 RED will be the independent third-party bioassay, without exception. Bioassay validation methodology to follow applicable protocols described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003). The UV system shall also be designed to deliver a minimum T1 RED of 15 mJ/cm² at peak flow, in effluent with a UV Transmission as described in Paragraph 1.04.D at end of lamp life (EOLL) after reductions for quartz sleeve fouling, with one bank of the UV system shut down. The basis for evaluating the T1 RED will be the independent UVDGM/IUVA 2006 third party bioassay, without exception.
 - a. The basis for evaluating the UV dose delivered by the UV system will be the manufacturer's biodosimetric performance validation testing conducted by a recognized independent 3rd party expert according to the procedures described in the US EPA UV Disinfection Guidance Manual (2006) and IUVA Uniform Protocol.
 - b. Validation testing shall have been conducted with an appropriate challenge organism reflecting the UV sensitivity of the targeted pathogens. For example, challenge organisms of T1 and Qβ are appropriately matched for fecal coliforms and E.Coli.
 - c. Manufacturers that base their system around a T1 challenge organism shall confirm that their system is also capable of providing dose of 30 mJ/cm² based on a sensitivity of an MS2 challenge organism described in NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).
5. The RED will be adjusted using an end of lamp life factor of 0.50 to compensate for lamp output reduction over the time period corresponding to the manufacturer's lamp warranty. The use of a higher lamp aging factor will be considered only upon review and approval of independent third party verified data that has been collected and analysed in accordance with protocols described in Chapter 3 of the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003).
6. The RED will be adjusted using a quartz sleeve fouling factor of 0.80 to compensate for quartz sleeve transmission reduction due to wastewater effluent fouling. The use of a higher quartz sleeve fouling factor will be considered only upon review and approval of independently verified data that has been collected and analysed in accordance with protocols described in Chapter 3 of the NWRI Ultraviolet Disinfection Guidelines for Drinking Water and Water Reuse (May 2003). The data recorded for the determination of the validated fouling factor must be obtained by testing the cleaning system in secondary wastewater effluent.
7. Independent validation for use of higher factors (lamp aging and sleeve fouling) must be submitted to the Engineer for consideration.

- F. The UV System Supplier shall furnish and commission the UV system as described in this specification and other associated documents, inclusive of all equipment, instrumentation, scope-specific piping systems, controls, integration, training, startup, commissioning and warranty support.
- G. The UV System Supplier shall provide the UV Product Engineering and Design Services in support of the treatment system design as described in this specification.
- H. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the UV System in accordance with the installation instructions provided by the Supplier. Once installed, the UV System shall be complete and operational with all control equipment and accessories as specified herein or as otherwise required for a fully functional and operational system. The UV Supplier must clearly identify in detail all exceptions to the Services and Scope of Supply described in this Specification and include such list with their proposal package

1.05 QUALITY ASSURANCE

- A. The equipment supplier must have at least fifteen continuous years of experience in the design, application and manufacture of UV disinfection equipment. All material and equipment shall be new and of the highest quality.
- B. In order to assure uniform quality, ease of maintenance and minimal parts storage, it is the intent of these specifications that all clarifier assemblies and accessories called for under this section shall be supplied by a single manufacturer or authorized sales representative. The equipment manufacturer or authorized sales representative shall, in addition to the Contractor, assume the responsibility for proper installation and functioning of the equipment.
- C. Manufacturer shall provide UV lamps, UV banks, ballasts, power distribution receptacles, monitoring panels, transition connections, and maintenance rack as a complete integrated package to ensure proper coordination, compatibility, and operation of the system.
- D. The Contract Documents represent the minimum acceptable standards for the equipment for this project. Equipment shall conform fully in every respect to the requirements of the respective parts and sections of the Drawings and specifications. Manufacturers shall modify, redesign, and furnish with special features or accessories, use materials or provide equipment with finishes as may be necessary to conform to the quality mandated by the technical and performance requirements of this specification.
- E. Drawing layouts, item weights and specification language for the UV system is based on Trojan Technologies, London, Ontario. UV equipment shall be provided by Trojan Technologies.

- F. Changes in architectural, structural, electrical, mechanical and plumbing requirements for the alternate shall be the responsibility of the Manufacturer requesting approval. This shall include the cost of redesign by affected designers. Any additional cost incurred by affected subcontractors shall be the responsibility of the Manufacturer and not the Owner.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Delivered materials shall be stockpiled and stored at locations approved by the Owner until required for installation. Materials shall be transported, delivered stored and handled in accordance with manufacturer's instructions.
- B. Shipping to Point of Destination: The Supplier shall include the cost of factory testing, freight charges, transit insurance, and taxes. Shipping of the equipment shall be F.O.B., full freight to jobsite.
- C. Final delivery schedule shall be coordinated with Contractor.

1.07 WARRANTIES

- A. The equipment manufacturer shall warrant the equipment being supplied to the Owner against defects in workmanship and materials for a period of 12 months from date of substantial completion or 18 months after shipment, whichever comes first. The warranty shall be in published form and apply to all similar units. A warranty offered by a representative will not be acceptable in lieu of the manufacturer's warranty.
- B. The UV lamps will be warranted for a minimum of 12,000 hours (non-prorated) or thirty-six (36) calendar months from shipment, whichever comes first. Pro-rated lamp warranties will not be accepted. On/off cycles are limited to an average of four (4) per day without exception.

PART 2 - PRODUCTS

2.01 MANUFACTURER

- A. Trojan Technologies
- B. Or Approved Equal
- C. Equipment of all manufacturers must be in accordance with the Contract Documents. Being named as a manufacturer does not eliminate their responsibility of providing equipment in compliance with the following specification section.

2.02 MATERIALS AND EQUIPMENT

- A. General

1. All module welded metal components in contact with effluent will be Type 316L stainless steel.
2. Lamp wiring shall be flexible conduit or Teflon™ coated cable, suitable for use in cable tray.
3. The system shall be designed for immersion of the UV lamps in the effluent within their protective quartz sleeve.
4. All materials exposed to UV light shall be 316 stainless steel, quartz glass, PTFE, FKM, or other suitable long-term UV resistant materials
5. The UV disinfection system supplied shall be UL, or equivalent, labelled and listed.

B. Lamp Array Configuration

1. The lamp array configuration will be uniform with all lamps parallel to each other and to the flow direction. The lamps will be evenly spaced in horizontal and vertical rows with centerline spacing equal in both directions.
2. The single array pattern will be continuous and symmetrical throughout the reactor.
3. The system will be designed for complete immersion of the UV lamps including both electrodes and the full length of the lamp tube in the effluent. Both lamp electrodes will operate at the same temperature and be cooled by the effluent.

C. UV Module

1. Each UV lamp module will consist of 4 lamps and their corresponding electronic ballast. Each lamp will be enclosed in its individual quartz sleeve, one end of which will be closed and the other end sealed by a lamp end seal and holder.
2. The electrical wires connecting the lamps to the electronic ballasts will be enclosed in the stainless steel frame. Systems where lamp wiring is submerged in the effluent and exposed to UV light will not be allowed.
3. Each UV module will be provided with a standard 120 Volt plug and weatherproof cable for connection to a receptacle. The cable will be 10 feet (304.8 cm) long. A total of 12 UV modules will be supplied. Lamp status will be displayed on top of each UV module using watertight LED indicator lights.
4. Modules will be approximately 68.2 inches (1732.28 mm) long, 20.16 inches (512.06 mm) high and 2.8 inches (71.12 mm) wide, weighing approximately 38 lbs. Materials of construction will be stainless steel type 316, anodized aluminum, quartz 214, and Teflon™, with UL rating of Type 6P

D. UV Lamps

1. UV system will use low pressure mercury slimline lamps of the hot cathode, instant start design.
 2. 90% of UV output will be within the wavelengths of 233.7 to 273.7 nm.
 3. The operating life of the lamp will be guaranteed for 12,000 hours, non pro-rated.
 4. Independent validation of lamps aging factor is required.
- E. Lamp End Seal and Lamp Holder
1. The open end of the lamp sleeve will be sealed by means of a sleeve nut which threads onto a sleeve cup and compresses the sleeve 'O' ring.
 2. The sleeve nut will have a knurled surface to allow a positive handgrip for tightening. The sleeve nut will not require any tools for removal.
- F. UV Lamp Sleeves:
1. Quartz sleeves to be Type 214 clear fused quartz circular tubing as manufactured by General Electric or equal.
 2. Quartz to be rated for UV transmission of 89% and not subject to solarization.
 3. The nominal wall thickness will be 1.0 to 0.08 inch (2 mm) to maximize UV transmission.
- G. Effluent Channel:
1. Each UV unit will be provided with one (1) effluent channel complete with drain provided by UV manufacturer, UV module support rack and downstream level control weir.
 2. The effluent channel will have the following dimensions as per the drawings: 24'-4" x 1'-10.25" x 3'-1"
- H. Level Control Weir:
1. Weir will be located downstream of the UV modules to maintain an average water depth of 12 inches (304.8 mm) and ensure lamp submergence at all times.
 2. Maximum effluent level variance from zero to peak flow will not exceed 1.5 inches (38.1 mm).
 3. Weir will be welded water tight and include a drain.
- I. Electrical
1. The UV disinfection system will be divided into 12 UV modules.
 2. Interconnecting Cables to be standard 120 Volt, weatherproof, 10 feet (304.8 cm) long and will be suitable for outdoor installation.
 3. Power Distribution Receptacles:

- a. 120 Volt receptacles rated for continuous outdoor use will be provided. Receptacles will be of the duplex type complete with ground fault interrupter circuitry.
 - b. Receptacles to be provided by the UV Manufacturer.
- 4. Power Consumption:
 - a. Maximum power draw to UV System will be 4,200 watts.
 - b. All electrical supplies will be 120 Volt, 60 Hz.
 - c. A separate 120 volt, 5 amp supply to be provided for the Monitoring System
- J. Power Distribution Receptacle (PDR):
 - 1. Duplex ground fault interrupter receptacle(s) will be provided by the UV Manufacturer.
 - 2. Receptacles will be mounted in an individual, impact resistant thermoplastic junction box complete with a Type 3R rain shield for outdoor installation.
 - a. Contractor to supply appropriate 120 Volt, single phase, 60 Hz circuit to power the PDRs which have a total current draw of approximately 38.4 amps. Contractor to be responsible for distributing the power from the main 120 Volt feed to the individual PDRs. Responsibility to be all encompassing and in accordance with the local electrical codes.
- K. Cleaning Procedure:
 - 1. The UV lamp modules will be cleaned by removing from the effluent channel and hand wiping the sleeves with an acid solution, using a non-abrasive cloth.
- L. Monitoring System:
 - 1. 2 submersible UV sensor(s) will continuously monitor the UV intensity produced in the bank of UV lamp modules. The sensor will measure the germicidal portion of the light emitted by the UV lamps.
 - 2. UV intensity will be indicated on a 3 character display in mW/cm².
 - 3. Elapsed time in hours (lamp age) will be indicated on a 5 character display.
 - 4. Both displays will utilize LEDs and will be visible through the panel door.
 - 5. A dry contact will be provided for remote indication of Low UV intensity alarm.
 - 6. Monitoring System will be enclosed in a fiberglass Type 4X wall mounted panel and is to be located less than twelve (12) feet 4 yard (3.66 meter) from the LED end of the UV Module.
- M. Transition Connections
 - 1. 1 inlet and 1 outlet transition box(es) will be supplied.

2. The material of construction for the transition boxes will be stainless steel type 304, 14 gauge.
3. Openings on the transition boxes (for flange connections) conform to ANSI standards and have dimensions as shown on the Contract Drawings.
4. 1 Turnbox(es) constructed of stainless steel type 304, 14 gauge will be supplied as per contract drawings

N. Maintenance Rack:

1. One (1) Type 304 stainless steel maintenance rack(s) will be supplied. The rack is designed to hold UV modules during service or maintenance.

O. Spare Parts:

1. The following additional parts will be furnished:
 - a. 8 UV lamps (per bank)
 - b. 8 Quartz sleeves (per bank)
 - c. 8 Lamp holder seals (per bank)
 - d. 2 Operators Kits (including face shield, gloves) (per bank)

2.03 LABELS

- A. Self-adhesive labels are acceptable for panel and equipment identification labels.

2.04 COATINGS

- A. Prepare surfaces, shop prime and finish paint with two finish coat of Supplier's standard paint system.
- B. Machined surfaces that are not painted shall be protected by coating with a corrosion-protective compound; either grease or light turbine oil as recommended by Supplier.

PART 3 - EXECUTION

3.01 GENERAL

- A. Contractor shall install the UV system equipment per the Equipment Manufacturer's directions and the drawings. Manufacturer will provide adequate protection of the equipment for shipment to the project site. Installation instruction will be provided that specifically outline installation of the equipment. Lifting instructions will be provided to assist the Contractor.
- B. Systems to be installed complete with all necessary connections, fittings, control equipment and fixed finger weir.
- C. The Contractor is responsible for any fastening or mounting appurtenances required to provide a complete and functional system, including stainless steel

anchor bolts. Supplier to provide template for mounting and anchoring equipment.

- D. Contractor responsible for coordinating final channel dimensions to accommodate manufacturer's installation recommendations for the specific UV disinfection equipment supplied.
- E. Contractor shall complete all electrical power and control connections as specified in Division 26.
- F. Contractor responsible for adequate amount of pipe, fittings, valves, and appurtenances required to provide a complete and functional system.
- G. Contractor shall verify all dimensions in the field to ensure compliance of equipment dimensions with the drawings. Contractor shall notify Engineer of significant deviations.

3.02 STARTING AND ADJUSTING

- A. Manufacturer's Service
 - 1. Provide services of an Experienced, Competent and Authorized Representative of Manufacturer for a minimum of three (3) days. Additional Manufacturer services for starting and adjusting shall be the responsibility of the Contractor.
 - 2. See Section 01 77 00 for additional requirements.

3.03 FUNCTIONAL TESTING

- A. Installation contractor will conduct functional testing as defined in Section 01 91 00.
- B. Provide services of an Experienced, Competent and Authorized Representative of Manufacturer for a minimum of one (1) day. Additional Manufacturer services for starting and adjusting shall be the responsibility of the Contractor

3.04 PERFORMANCE AND OPERATIONAL TESTING

- A. Provide commissioning plan in accordance with requirements of Section 01 91 00. Contractor shall be responsible for providing any additional services of manufacturer's representative for functional and performance and operation testing if necessary for commissioning.
- B. Final acceptance of equipment will not be provided until completion of Performance and Operational Testing (POT).
- C. Performance and Operation Testing period shall demonstrate that the UV disinfection system meets the performance requirements of this specification for

the duration of the POT. Successful demonstration shall be defined as meeting permitted disinfection limits as well as a fully functional system in automatic and manual modes.

3.05 CLASSROOM AND DEMONSTRATION TRAINING

- A. Operator training shall be conducted by qualified Manufacturer's representative and be conducted separately from start-up and Functional testing services.
 - 1. Classroom training shall occur after completion of Pre-functional Testing and prior to Performance and Operation Testing. Provide one (1) full day on site, eight (8) hours minimum classroom training.
 - 2. Demonstration training shall occur after written acceptance of Functional Test completion. Provide one (1) full day on site, eight (8) hours minimum demonstration training.
 - 3. Contractor will complete Performance and Operational Testing after written acceptance of Functional Testing by Engineer.

END OF SECTION 46 66 10